PART IV

APPENDIX A THROUGH APPENDIX E

Appendix A LIST OF SPECIES

A.1 USFWS ESA-listed Species Occurring in the Action Areas

Table A-1 presents the USFWS ESA-listed species that occur in the action areas. The USFWS verified this list in a letter dated September 28, 2004.

Reclamation reviewed the listed species that may occur in the action areas. During the information-gathering and initial analysis stages, Reclamation concluded that some of the ESA-listed species were not found in the action areas, were strictly terrestrial species, or, if they were found in the action areas, would not be affected by the proposed actions. Reclamation determined that further analysis for these species was unnecessary. Section A.3 presents, for information only, the rationale behind these determinations.

Table A-1. USFWS ESA-listed species in the action areas.

Common Name	Scientific Name	Status
Bald eagle	*Haliaeetus leucocephalus*	Threatened
Banbury Springs lanx	*Lanx* sp.	Endangered
Bliss Rapids snail	*Taylorconcha serpenticola*	Threatened
Bruneau hot springsnail	*Pyrgulopsis bruneauensis*	Endangered
Bull trout	*Salvelinus confluentus*	Threatened
Canada lynx	*Lynx canadensis*	Threatened
Gray wolf	*Canis lupus*	Experimental/ non-essential
Grizzly bear	*Ursus arctos*	Threatened
Idaho springsnail	*Pyrgulopsis idahoensis*	Endangered
MacFarlane's four o'clock	*Mirabilis macfarlanei*	Threatened
Northern Idaho ground squirrel	*Spermophilus brunneus brunneus*	Threatened
Snake River physa	*Physa natricina*	Endangered
Utah valvata snail	*Valvata utahensis*	Endangered
Ute ladies'-tresses	*Spiranthes diluvialis*	Threatened
Water howellia	*Howellia aquatilis*	Threatened

A.2 NOAA Fisheries ESA-listed Species Occurring in the Action Areas

Table A-2 presents the NOAA Fisheries ESA-listed and proposed species that occur in the action areas. It also shows the three species for which NOAA Fisheries has designated critical habitat. NOAA Fisheries verified this list in a letter dated October 20, 2004.

Table A-2. NOAA Fisheries ESA-listed and proposed species in the action areas.

Common Name	Scientific Name	Status
Chinook salmon	*Oncorhynchus tshawytscha*	
Snake River spring/summer run ESU [1]		Threatened
Snake River fall run ESU [1]		Threatened
Lower Columbia River ESU		Threatened
Upper Columbia River spring run ESU		Endangered
Upper Willamette River ESU		Threatened
Columbia River chum salmon ESU	*Oncorhynchus keta*	Threatened
Lower Columbia River coho salmon ESU	*Oncorhynchus kisutch*	Proposed
Snake River sockeye salmon ESU [1]	*Oncorhynchus nerka*	Endangered
Steelhead	*Oncorhynchus mykiss*	
Lower Columbia River ESU		Threatened
Middle Columbia River ESU		Threatened
Upper Columbia River ESU		Endangered
Upper Willamette River ESU		Threatened
Snake River Basin ESU		Threatened

1 These species have designated critical habitat in the action areas.

A.3 ESA-listed Species for which Reclamation Determined No Effect

A.3.1 Banbury Springs Lanx

Banbury Springs lanx (*Lanx* sp.), currently listed as endangered, is a snail found only in three alcove spring complexes adjacent to the mainstem Snake River at Banbury Springs, Box Canyon Springs, and Thousand Springs upstream from Hagerman (RM 584.6 to 589). These springs are all located 50 miles or more downstream from Milner Dam (RM 639.1). Cazier (1997) notes that this species has shown no range expansion and remains confined to the three known spring areas. Hydroelectric operations and high spring-time river flows do not affect these three springs. Reclamation has determined that the proposed actions will have no effect on the Banbury Springs lanx or habitat important to its survival.

A.3.2 Bruneau Hot Springsnail

Bruneau hot springsnail (*Pyrgulopsis bruneauensis*), currently listed as endangered, is found only in a few small spring complexes in the lower Bruneau River. Reclamation operation and maintenance activities do not affect or influence the Bruneau River subbasin. Reclamation has determined that the proposed actions will have no effect on the Bruneau hot springsnail or habitat important to its survival.

A.3.3 Canada Lynx

The Canada lynx (*Lynx canadensis*) was listed as threatened for the contiguous United States on April 24, 2000. In the action areas, the Canada lynx occurs in subalpine coniferous forest in Idaho and Wyoming that receive deep snowfall.

Canada lynx primarily prey on the snowshoe hare (*Lepus americanus*) that inhabits forests with dense understories. The hare has evolved to survive in areas that also receive deep snow. There is habitat suitable to support Canada lynx and snowshoe hare primarily near the action areas of Lake Cascade, Jackson Lake, and Deadwood and Palisades Reservoirs. Reservoir drawdown does not affect the surrounding habitat, which occurs above the maximum high-water line. Further, no evidence has been found to show that the Canada lynx requires the use of riverine habitats. Reclamation has determined that the proposed actions will have no effect on the Canada lynx or habitat important to its survival.

A.3.4 Grizzly Bear

In 1975, the 8-year-old endangered listing for the grizzly bear (*Ursus arctos*) was amended to threatened in the lower 48 states (except where listed as an experimental population) (40 FR 31734). Currently, there are five grizzly bear sub-populations outside Alaska and Canada, in Wyoming, Washington, Idaho, and Montana. Distribution of the grizzly bear in the action areas occurs in the Greater Yellowstone Area (GYA), which encompasses parts of Idaho, Wyoming, and Montana. The grizzly population in the GYA has grown steadily since it was listed and is now being considered for delisting. Reclamation's operations at facilities in the GYA have had and will continue to have no effect on the species (USBR 2004). Reclamation has determined that the proposed actions will have no effect on the grizzly bear or habitat important to its survival.

A.3.5 MacFarlane's Four-o'clock

MacFarlane's four-o'clock (*Mirabilis macfarlanei*) was first listed as endangered in 1979 but reclassified as threatened in 1996 (61 FR 10693). This perennial plant has a deep tap root and grows about 18 inches high. The vibrant magenta flowers are broadly tubular and grow in the leaf axils. It is found in three disjunct locations, one of which is along the Snake River in Hells Canyon in both Idaho and Oregon. It is an upland species, found generally at low elevation on steep talus slopes in canyonland corridors where the climate is regionally warm and there is little precipitation. Reclamation has determined that the proposed actions will have no effect on MacFarlane's four-o'clock or habitat important to its survival.

A.3.6 Northern Idaho Ground Squirrel

The northern Idaho ground squirrel (*Spermophilus brunneus brunneus*) was federally listed as a threatened species on April 5, 2000. A USFWS-published recovery plan (2003) provides the following data on the ground squirrel.

This subspecies is known to exist only in Adams and Valley Counties in western Idaho. The entire range of the subspecies is about 1,200 square miles. As of 2002, 34 of 40 known population sites were extant. The subspecies declined from an estimated 5,000 individuals in 1985, to less than 1,000 individuals by 1998 when it was proposed for listing. Following extensive census data from the spring of 2002, the USFWS estimated the population to be 450 to 500 animals.

The northern Idaho ground squirrel is known to occur in shallow, dry rocky meadows usually associated with deeper, well-drained soils and surrounded by ponderosa pine and Douglas-fir forests at elevations of about 3,000 to 5,400 feet. Similar habitat occurs up to at least 6,000 feet. Consequently, ponderosa pine/shrub-steppe habitat association with south-facing slopes less than 30 percent at elevations below 6,000 feet is considered to be potentially suitable habitat. Forest encroachment into formerly suitable meadow habitats is the species' primary threat. Forest encroachment causes habitat fragmentation, eliminates dispersal corridors, and confines squirrel populations into small isolated habitat islands. The subspecies is also threatened by land use changes, recreational shooting, poisoning, genetic isolation, genetic drift, random naturally occurring events, and competition from the larger Columbian ground squirrel (*S. columbianus*).

Lake Cascade is the only Reclamation facility located within the area of the northern Idaho ground squirrel's probable historical distribution (USFWS 2003). However, none of the known populations are adjacent to Lake Cascade or along the North Fork Payette River downstream from the lake (USFWS 2003). The northern Idaho ground squirrel probably does not occur adjacent to any Reclamation facilities and is not associated with shoreline or riparian habitats. Reclamation has determined that the proposed actions will have no effect on the northern Idaho ground squirrel or habitat important to its survival.

A.3.7 Water Howellia

Water howellia (*Howellia aquatilis*), currently listed as threatened, is an annual that grows as a submerged plant in bottom sediments of ponds, sloughs, and cutoff river meanders. It is known to occur at one site in Latah County, Idaho, and in Washington and Montana. These locations are outside the areas of Reclamation's influence. Suitable habitat to support this species is not likely present in the Snake River basin (Moseley 1997). Reclamation has determined that the proposed actions will have no effect on water howellia or habitat important to its survival.

A.4 Literature Cited

Parenthetical Reference	Bibliographic Information
40 FR 31734	Federal Register. 1975. U.S. Fish and Wildlife Service, Endangered and Threatened Wildlife; Amendment Listing the Grizzly Bear of the 48 Conterminous States as a Threatened Species. July 28, 1975, Vol. 40, No. 145, pp. 31734-31736.
61 FR 10693	Federal Register. 1996. U.S. Fish and Wildlife Service Final Rule: Endangered and Threatened Wildlife and Plants; Reclassification of *Mirabilis Macfarlanei* (MacFarlane's Four-O' clock) From Endangered to Threatened Status. March 15, 1996, Vol. 61, No. 52, pp. 10693-10697.
Cazier 1997	Cazier, D. 1997. Aquatic Invertebrate Biologist. Idaho Power Company. Personal communication.
Moseley 1997	Moseley, R.K. 1997. Idaho Fish and Game Department, Boise, Idaho. Personal communication.
USBR 2004	U.S. Bureau of Reclamation. 2004. "Rationale for Determination of No Effect for the Grizzly Bear." Snake River Area Office, Pacific Northwest Region, Boise, Idaho.
USFWS 2003	U.S. Fish and Wildlife Service. 2003. Recovery Plan for the Northern Idaho Ground Squirrel (*Spermophilus brunneus brunneus*). Region 1, Portland, Oregon.

Appendix B OPERATIONS AND MAINTENANCE ADDENDUM

Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004) provides an overview of future operations at Reclamation facilities in the upper Snake River basin. During this consultative process, Reclamation determined that this document did not fully reflect some facets of the proposed actions. This appendix presents this addendum of operations and routine maintenance information.

B.1 Salmon Flow Augmentation

This section first describes how Reclamation will provide up to 487,000 acre-feet annually for salmon flow augmentation. Flow augmentation is a component of four proposed actions: future O&M in the Snake River system above Milner Dam, the Boise River system, the Malheur River System, and the Payette River system; and future provision of salmon flow augmentation from the rental or acquisition of natural flow rights. Current State of Idaho legislation allowing flow augmentation expires on January 1, 2005. These proposed actions are contingent on State legislation for salmon flow augmentation and are consistent with a proposed Nez Perce water rights settlement agreement.

B.1.1 Sources for Flow Augmentation

Uncontracted Space

Space not under contract in Reclamation's storage reservoirs is a reliable source of water in most years. Currently, uncontracted space is administratively assigned to a variety of purposes, including mitigation, conservation pools, reservoir evaporation, streamflow maintenance, and salmon flow augmentation. Reclamation relies on this space as much as possible in meeting its commitment to provide augmentation flows. By 1998, Reclamation had acquired reservoir space for 22,896 acre-feet in the reservoirs upstream from Milner Dam and 37,378 acre-feet in the Boise River basin. In addition, Reclamation has administratively assigned for salmon flow augmentation 3,554 acre-feet of storage in the Boise River basin and 95,000 acre-feet of storage in the Payette River basin. This uncontracted space has been assigned for salmon flow augmentation for as long as it is needed for ESA-listed anadromous fish runs. Reclamation treats reacquired space the same as space not under contract. It has the same reliability of refill and is used as much as possible for salmon flow augmentation.

Rental Pools

Reclamation does not control sufficient uncontracted storage or natural flow water rights to provide the 487,000 acre-feet for flow augmentation, so Reclamation will attempt annually to rent additional water to meet part of its commitment of 487,000 acre-feet from rental pools.

Reclamation complies with State law, State regulations, water bank rules, and local rental pool procedures when acquiring and providing water for salmon flow augmentation. The State of Idaho enacted legislation (Idaho Code, Chapter 17, Section 42-1763B) to provide interim approval for Reclamation to rent storage water through the Idaho rental pools' water banks. This legislation expires on January 1, 2005.

Water rental pools operate under State law and at the direction and under the rules of the Idaho Water Resource Board (IWRB). The local water rental pool organization determines local water rental pool rules and leasing prices; the IWRB then approves or denies these rules and prices. The watermaster administers the rental pool under the guidance of the local water rental pool organization. Reclamation, as a storage facility owner and contractor, is also involved and must also approve the rules and rates for Federal storage.

Water rentals reduce the volume of reservoir carry-over at the end of the irrigation season. This reduces the likelihood that reservoirs will refill the following year. Since the mid-1980s and prior to Reclamation's current efforts to provide augmentation flows, the rental pools have been governed by a "last to fill" provision for water used downstream from Milner Dam or outside the Boise and Payette River systems. This rule avoids injury to storage rights of those who rely on carryover storage the following year. Thus, the parties making water available for salmon flow augmentation have assumed any risks that the evacuated space may fail to refill the following year.

For the rental pools, a proposed Nez Perce water rights settlement agreement contemplates that the agreement's parties will not exercise agricultural preferences over Reclamation's reacquired or uncontracted space.

The Shoshone-Bannock Tribes have rights to contract space in American Falls Reservoir, which they may rent for downstream uses in accordance with the terms of their water rights settlement. The settlement provides that the Tribes' rentals will be in accordance with a Tribal water bank. The Tribes and Reclamation have entered into a long-term lease for 38,000 acre-feet of space in American Falls Reservoir. Drought prevented this water from being available in 2002, 2003, and 2004 because the water was used to meet irrigation commitments for the Fort Hall Project.

Reclamation may also arrange for Idaho Power to rent Boise Project, Arrowrock Division uncontracted and powerhead space under a separate provision of Idaho law (Idaho Code, Section 42-108A), if necessary. Reclamation does not anticipate exercising this provision.

Natural Flows

Malheur River Basin

Reclamation has permanently acquired 17,847 acre-feet of natural flow rights in Oregon. These are rights to the Malheur River with supplemental Snake River rights. To the degree the Malheur primary rights would be curtailed under the prior appropriation doctrine, the supplemental rights on the Snake River would be available. The acquired Snake River rights have never been curtailed to meet senior rights.

Snake River below Milner Dam

In recent years, severe drought conditions restricted the volume of storage water available for salmon flow augmentation. This condition was not unpredicted; Reclamation's hydrologic modeling since the mid-1990s had predicted that water would not be available in all years. Beginning in 2002, Reclamation rented water from holders of natural flow water rights along the Snake River in Idaho below Milner Dam.

Future provision of salmon flow augmentation from the rental or acquisition of natural flow rights constitutes an additional source for flow augmentation water. Reclamation will rent or acquire consumptive natural flow water rights from the Snake River between Milner and Swan Falls Dams (high-lift pumpers) during the salmon flow augmentation period. When added to the other sources, this water increased the total water available for flow augmentation to 487,000 acre-feet.

Powerhead

Reclamation may use powerhead at Anderson Ranch Reservoir to meet salmon flow augmentation objectives (this occurred in 1993, 1994, and 2002).

As a last resort source for flow augmentation, Palisades Reservoir powerhead space. Reclamation has not used Palisades Reservoir powerhead recently. The Idaho

Department of Water Resources asserts that the water rights licenses for Reclamation projects only authorized filling powerhead space at Palisades Reservoir one time, and that powerhead water is not eligible for State protection through the State-authorized rental pools.

Reclamation will seek a water right for its Palisades powerhead space. No more than 78,500 acre-feet of water stored in that space (one-half of the inactive space or the total accrual to that space, if less) would then be available for salmon flow augmentation in accordance with these provisions:

- Palisades Reservoir powerhead can only be used if the sum of all other sources in this and other proposed actions is less than 427,000 acre-feet. If water from all other sources, including natural flows, is sufficient to provide 427,000 acre-feet for flow augmentation, Reclamation will not release powerhead.
- Use of powerhead cannot interfere with provision of established minimum conservation pools.
- When used for flow augmentation, powerhead space is last of the last space to refill.
- Use of powerhead space shall comply with State law.
- Use of powerhead cannot interfere with diversions of water in reservoir pools or natural flow, or the ability of spaceholders to refill and use active storage.
- Use of powerhead will not affect rates for hydroelectric power and energy paid by irrigation entities that receive preference pumping power from Reclamation.

B.1.2 Releases of Water

Flow augmentation is primarily for juvenile salmon migration between April 20 and August 31. Reclamation generally assumes the 487,000 acre-feet would be needed in July and August with recession of natural flows and the beginning of storage draft for irrigation. Storage releases for irrigation generally begin by early July but may begin as early as April or May in low water years.

The strategy for releasing flow augmentation water depends on the volume of water available and the timing of the natural runoff. Typically, Reclamation does not release augmentation water as long as natural flows are sufficient to meet the flow objectives at Lower Granite Dam. All released water must reach Brownlee Reservoir by about August 31 each year. The State watermasters are responsible for the regulation of rental water delivery. Reclamation, the State, spaceholders, and contract holders discuss and determine the timing and release of flow augmentation water.

Boise River Releases

The Boise River system reservoirs have released about 41,000 acre-feet of water for flow augmentation in recent good water years. Reclamation has typically requested that releases for salmon flow augmentation begin when storage releases for irrigation begin. This release at Lucky Peak Dam is usually 400 cfs above the volume of stored water released for irrigation. Flows are usually about 1500 cfs below the Boise River Diversion Dam. The Ada County Parks and Waterways Department considers flows above 1,500 cfs unsafe for floaters in the lower Boise River, and flows above 1,500 cfs damage gravel pushup dams.

Payette River Releases

The Payette River system reservoirs have provided about 160,000 acre-feet of water for flow augmentation in good water years. The Payette River Watershed Council meets on a regular basis to discuss a variety of operational issues. Reclamation participates in these meetings and has attempted to develop consensus on a flow release plan.

Payette River augmentation releases typically begin when the reservoir system begins to draft for irrigation, usually by late June or early July, although this has occurred earlier in dry years. With the final volume of available water and the start time known, Reclamation formulates release strategies that derive the maximum benefit to other functions, such as flows for recreational floating, recreational levels for lake boating, water quality, power production, etc., and still delivers augmentation volumes by August 31. Payette River Watershed Council recommendations are also taken into consideration when possible. Flow augmentation rates average from about 800 cfs to 1,500 above irrigation deliveries, depending on volume, start time, and natural flows in the system.

Snake River Releases above Milner Dam

Flow augmentation releases are made at Milner Dam, a private dam and the lowest point of regulation within the Minidoka and Palisades storage system. Milner Pool has a modest volume of storage, so release from up-river storage reservoirs are necessary to provide the water needed and sustain Milner Pool storage volumes at adequate levels.

Reclamation will adjust the timing and volume of salmon flow augmentation at Milner Dam to facilitate delivery of the upper Snake storage water in a timely manner. The Milner Agreement, which limited flows at Milner Dam to 1,500 cfs, expired in 1999. The proposed Nez Perce water rights settlement agreement contemplates a renewed Milner Agreement with a modified flow limitation. Release rates and starting times will be flexible enough to ensure that the entire augmentation volume will reach the lower Snake River by August 31.

Absent a new Milner Agreement, Reclamation proposes to release salmon augmentation flows of up to 3,000 cfs past Milner Dam. Salmon releases will begin on or after June 20 and will continue until complete, usually by August 20. Augmentation will begin after the maximum reservoir fill is achieved and after flood releases past Milner Dam are over. Ramp-up will be limited to about 500 cfs per day with hourly changes greater than 100 cfs avoided. Ramp-down will be at approximately 100 cfs per day to accommodate listed snails. The maximum flow release at Milner Dam will be adjusted based on the volume of water available but will be no less than 1,200 cfs. Salmon augmentation releases of up to 3,000 cfs at Milner Dam may be necessary before the end of the flow augmentation period in order to satisfy USFWS ramping criteria. This will occur only when flow augmentation is delayed beyond July 4 due to late runoff conditions. In order to maintain a relatively constant pool elevation at the Milner Pool, gradual changes in releases at American Falls and Minidoka Dams will be necessary. Providing flow augmentation below Milner Dam will require close coordination with Idaho Power.

The water Reclamation provides for salmon flow augmentation will be added to the minimum flow established under the October 1984 Swan Falls Agreement. The proposed Nez Perce water rights settlement agreement also incorporated the Swan Falls Agreement between the State of Idaho and Idaho Power into the settlement in part to continue to protect Snake River flows at the Murphy gage (immediately downstream from Swan Falls Dam). This agreement stipulates that minimum flow levels in the Snake River at the Murphy gage are 3,900 cfs from April 1 to October 31, and 5,600 cfs from November 1 to March 31. The rights will be honored in priority in accordance with the terms of the Swan Falls Agreement.

B.2 Additional Payette River System Water to Supplement Irrigation in Dry Years

A proposed Nez Perce water rights settlement contemplates Reclamation providing up to an additional 30,000 acre-feet of water from the Payette River system for Boise and/or Payette River basin irrigation rental in extremely dry years. This water would be from sources exclusive of Reclamation’s 95,000 acre-feet of reassigned space used for flow augmentation (69,600 acre-feet from Lake Cascade and 25,400 acre-feet from Deadwood Reservoir).

This provision is triggered when Reclamation's April 1 forecast for the Boise River at Lucky Peak is less than 570,000 acre-feet or when Reclamation's April 1 forecast for the Payette River at Horseshoe Bend is less than 700,000 acre-feet. For the 83-year period of record from 1920 to 2002, this condition occurred in 8.4 percent of the years (7 out of 83 years) in both the Boise and Payette River basins. When this trigger occurs, Reclamation may consign water to either or both Water District 63 or 65 rental pools for one-year rental.

Operationally, Reclamation will use uncontracted space at Deadwood Reservoir. Reclamation has administratively reserved 30,000 acre-feet of space in Deadwood Reservoir to maintain a 50-cfs winter instream flow downstream from the dam. This entails uncontracted space in the reservoir and is not part of the volume reserved to maintain a conservation pool of 50,000 acre feet or that used for flow augmentation.

Reclamation would provide 30,000 acre-feet of water for irrigation by making this water available during those years when a trigger occurs. Boise River basin water users would obtain this water through an exchange. Reclamation has similarly used this uncontracted water several times in the past, most recently in 2002 and 2003, without violating the 50,000-acre-foot minimum pool in Deadwood Reservoir and the 50-cfs winter streamflow because natural inflow to Deadwood Reservoir has been greater than 50-cfs during the winter months. For example, in all years for the 1971 through 2003 period, including the very dry years of 1977, 1992, 1994, and 2001, winter inflows at Deadwood Reservoir have exceeded 50 cfs. Therefore, Reclamation has been able to maintain the 50-cfs outflow at Deadwood Dam and a 50,000-acre-foot conservation pool, even if the beginning winter reservoir elevation is already at conservation pool elevation.

Water released to maintain the winter instream flow is deducted from Reclamation's uncontracted storage space. Inflow to the reservoir accrues to reservoir spaceholders on a pro rata basis, and Reclamation accrues some of the inflow to its uncontracted space even while releasing 50 cfs. This means at least 50,000 acre-feet of water will physically remain in Deadwood Reservoir, although technically some of this water may be accruing to irrigation storage accounts. Space evacuated for salmon flow augmentation is subject to a last-to-fill rule.

This operation does risk the possibility that if there are multiple consecutive dry years, and if Deadwood Reservoir fails to fill, Reclamation may not be able to maintain a 50,000-acre-foot conservation pool. Reclamation's uncontracted space would also have failed to fill, and consequently, as Reclamation released water to honor irrigation storage contract obligations, the reservoir may drop below the conservation pool elevation.

Despite this risk, it is unlikely that a full 30,000-acre-foot shortage would ever occur. System flexibility allows water to be supplied for irrigation or salmon flow augmentation through exchanges with other reservoirs. Another reservoir may be able to supply water to meet a potential shortfall for a year or two following this operation. For example, Reclamation may use up to 7,000 acre-feet of conservation pool at Lake Cascade. In the years Reclamation has employed this operational strategy, Deadwood Reservoir volume has not fallen below the conservation pool volume, and Reclamation has been able to provide the winter instream flow below Deadwood Reservoir. At most, Reclamation estimates the conservation pool could be reduced by up to 10,000 acre-feet (down to 40,000 acre-feet) in a small percentage of years, mainly multiple successive dry years. The modeled proposed actions predict that up to about 4,000 acre-feet of the conservation pool may be used about 7 percent of the time. In addition, at Lake Cascade, the modeled proposed actions predict that the conservation pool will be maintained. As the modeled tables in Appendix D show, the extreme minimum volume of contents at Deadwood Reservoir would be 46,621 acre-feet.

B.3 Minimum Winter Flows below Owyhee Dam

The *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (USBR 2004) notes that at the discretion of the Joint Committee (Owyhee, Gem, and Ridgeview Irrigation Districts), releases below Owyhee Dam are made to maintain instream flows of 15 to 20 cfs between the irrigation seasons in years of good carryover. In the summer of 2004, the irrigation districts adopted an environmental commitment to provide a 30-cfs minimum flow below Owyhee Dam from October 15 through April 15. The districts have agreed to adhere to this environmental commitment except during or immediately following times of irrigation shortage. During these periods, the districts would proportionately reduce the releases.

B.4 Routine Maintenance

Water conveyance and control facilities require periodic inspection, maintenance, and repair. Those proposed actions that include routine maintenance, inspection, and repair activities are limited to those actions' associated features and facilities. Reclamation (or the operating entity) prepares a yearly program for routine maintenance activities for review, approval, and execution. Reclamation (with the operating entity, where applicable) also inspects the major features described in this document every three to six years. Inspection reports are developed and recommendations are incorporated into the yearly routine maintenance programs where applicable. Some maintenance, inspection, and repair activities are not routine; these activities are not part of the proposed action, and they would be consulted on separately.

Reclamation (or the operating entity) will take advantage of low river conditions or low reservoir elevations when possible to accomplish repairs or inspections so that there is little or no affect on normal operations. In some cases, however these activities may require reducing or temporarily suspending river flows. However, this is avoided whenever possible and depends on the water conditions of that particular year.

Scheduled maintenance and inspections usually occur during lower flows in the late summer, fall, or winter. If possible, Reclamation (or the operating entity) reroutes river or waterway flows around the work area. For example, inspection, maintenance, and repair of the spillway discharge tunnel at Owyhee Dam can occur if river flows are routed through the river outlet works or the powerplant; in this scenario, the activity does not affect river flows. Where this is not possible, river flows may be temporarily suspended for the duration of the work. This can potentially occur at Agency Valley, Black Canyon Diversion, Boise River Diversion, Deadwood, Island Park, Mason, Ririe, Thief Valley, Unity, and Warm Springs Dams. Normal operation of Grassy Lake and Ririe Dams includes shut down at the end of the irrigation season.

The following eight subsections summarize the categories of routine maintenance activities that are part of the proposed actions. It is difficult to predict the details associated with activities for each of the facilities over a 30-year term. Therefore, as part of the proposed action, Reclamation will annually review its maintenance program activities and meet with USFWS and NOAA Fisheries to discuss routine maintenance program activities that require operations outside the range described in this biological assessment. The Services and Reclamation would then determine if any upcoming routine maintenance activities require supplemental analysis and/or consultation.

Routine Inspection of All Discharge Features

Reclamation inspects spillways, canal headworks, river outlet works, powerplant outlet works, pumping plant equipment, and associated equipment at least every six years. These inspections are typically performed under dewatered conditions but can be performed by divers, climbers, and other specially trained personnel. Whenever possible, inspections are scheduled to minimize effects to water deliveries and environmental and other interests. The inspection of these features may require temporary suspension or diversion of flow via another discharge feature for minutes or hours to ensure the safety of inspection personnel.

Periodic Testing of All Mechanical Equipment

Reclamation strives to operate each gate and valve through at least one complete cycle each year. Gate and valve operation under both balanced (operation in dry conditions or equal head on both sides of the gate or valve) and unbalanced head is critical to ensure the reliability of the equipment. In many cases, spillway gate testing is limited to operation during dewatered conditions or a portion of the full operating cycle due to potential impacts downstream. The testing of gates and valves typically results in minor or no fluctuation in the downstream waterway.

Periodic testing of other mechanical equipment such as compressors for air bubbler ice prevention systems, emergency backup generators, and pumps, is required to ensure that the equipment is operating satisfactorily.

Routine Maintenance of Discharge Features and Associated Equipment

This work includes concrete repairs, protective coating repairs, and maintenance of mechanical equipment. Whenever possible, Reclamation schedules maintenance such that impacts to streamflows, water deliveries, or environmental or other interests are minimal. Maintenance activities may require dewatering, temporary suspension or rerouting of flow via another discharge feature to allow access to the pertinent feature, curing of repair material such as concrete and protective coatings, or to ensure the safety of maintenance personnel. A reservoir may be temporarily surcharged to allow diversion of flow via a spillway to allow repair of river outlet works features.

Vegetation Control

Reclamation must prevent the growth of trees and other deep-rooted vegetation on and adjacent to all embankments, concrete structures and other appurtenant features, and along the alignment of buried features. This work is necessary to reduce the risk of structural problems associated with root systems and rodent burrows. In addition, vegetation control is needed such that visual inspection of the facilities is not compromised. Methods of vegetation control include pulling, cutting, or herbicide application, which is employed in accordance with EPA label and other applicable rules and regulations.

Rodent Control

Reclamation must prevent or minimize rodent populations on and near embankments because of the risk of structural problems associated with burrows. Methods of rodent control include shooting, poisoning, and trapping and relocation, which are employed in accordance with EPA label and other applicable rules and regulations.

Crest Roadway Grading

The roadway surface across the top of embankment dams requires periodic grading to ensure that surface runoff drains toward a protected slope (typically the upstream face of the dam).

Debris Removal

Debris carried into a reservoir must be removed to avoid complications related to controlled discharges. Methods for debris removal include manual collection and disposal and flushing the debris via spillway discharges. Manually collected debris is disposed of through burning, stockpiled in a public area, or removed by another party (for example, a landscape business) through a mutual agreement.

Maintenance of Instrumentation Devices

Reclamation must maintain the instrumentation installed in and near a dam to ensure the quality of the data collected. This work may entail removal of moss, algae, or a beaver dam adjacent to a seepage measurement device; vegetation control adjacent to an instrument; or repair of vandalism damage.

Appendix C HISTORICAL HYDROLOGIC DATA

C.1 Historical Reservoir Contents and Outflows

Table C-1 and Table C-2 show the maximum, median, and minimum end-of-month reservoir contents and outflows for the period of record from 1971 to 2003. These tables depict the entire range of operations that have occurred for the period of record. The tabulated data does not represent a single water year, but rather they are a composite of the records for each individual day within each month. These tables show companion data to the summary hydrographs presented in Appendix B of the Reclamation's *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir* (2004). This appendix provides the information summarized in the tables for all reservoirs included in this consultation.

C.2 Historical Record of Salmon Flow Augmentation Sources and Volumes

The flow augmentation tables in Table C-3 and Table C-4 show the volumes of salmon flow augmentation Reclamation has provided from the upper Snake River since 1991 and the storage sources for these volumes. In the early 1990s, drought conditions severely reduced the availability of rental water. In 1992, there was no rental water available for salmon flow augmentation. In 1993 and 1994, Reclamation used powerhead space to ensure flow augmentation. In 2001, there was very little water available to rent; further, the declared "power emergency" prevented Reclamation from using powerhead space. The severe drought of recent years continued into 2004. For the Snake River at Heise, 2001, 2002, 2003, and 2004 have been among the driest years of record. Taken consecutively, they represent the driest period of record.

Table C-1. Historical maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs (1971 to 2003). (Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake (reservoir storage does not include an unquantified natural lake storage)												
Maximum	664,626	657,849	679,929	694,322	693,345	674,572	716,643	850,838	874,138	854,200	843,181	764,712
Median	549,214	546,700	557,670	566,857	566,385	556,734	555,192	493,900	708,298	772,686	610,502	545,820
Minimum	57,708	59,310	68,000	82,300	82,700	90,600	74,525	46,200	132,500	207,000	119,600	55,000
Palisades Reservoir												
Maximum	1,399,684	1,401,158	1,396,730	1,378,639	1,364,499	1,399,351	1,406,000	1,410,542	1,419,174	1,411,033	1,400,672	1,403,907
Median	1,098,878	1,084,500	1,119,382	1,168,000	1,119,399	1,026,000	848,973	863,373	1,232,219	1,312,960	1,096,440	1,025,330
Minimum	206,524	218,764	318,428	390,706	453,849	397,953	258,826	239,549	557,936	373,936	268,917	206,925
American Falls Reservoir												
Maximum	1,548,027	1,347,000	1,407,099	1,537,334	1,588,022	1,682,000	1,703,000	1,715,000	1,735,769	1,712,000	1,672,590	1,527,808
Median	421,875	683,939	864,490	983,556	1,172,534	1,382,000	1,536,207	1,571,694	1,473,949	1,103,340	711,097	349,590
Minimum	0	130,980	403,180	671,333	902,296	861,400	972,700	869,060	615,910	168,880	13,500	0
Lake Walcott												
Maximum	213,350	210,408	199,010	192,340	198,930	213,840	220,430	218,140	218,380	217,734	216,930	215,970
Median	192,666	158,813	153,300	154,017	154,856	169,938	207,273	209,900	209,945	210,296	209,945	209,341
Minimum	109,960	108,790	107,450	117,889	136,060	142,661	154,327	200,399	199,345	198,311	133,970	13,560
Arrowrock Reservoir												
Maximum	193,688	230,005	281,919	284,090	292,152	286,600	286,600	288,736	291,616	290,400	251,136	197,569
Median	62,030	106,192	143,095	187,950	219,175	215,020	205,822	200,820	257,155	205,330	88,130	37,820
Minimum	0	23,150	48,227	67,727	68,254	41,551	16,470	9,380	7,800	5,292	1,757	0

Table C-1. Historical maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs (1971 to 2003), continued. Table reflects total capacity including active, inactive, and dead storage.

Location	Reservoir Contents (acre-feet)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir												
Maximum	492,095	492,002	457,373	463,032	461,160	442,800	477,432	497,500	502,600	500,487	493,048	491,100
Median	382,970	370,850	369,086	350,600	335,998	312,076	306,455	373,204	474,202	472,900	422,530	396,515
Minimum	62,870	56,754	50,592	44,449	40,156	39,333	76,681	124,468	124,344	92,338	81,058	71,086
Lucky Peak Reservoir												
Maximum	255,097	254,197	252,797	253,197	260,597	270,997	294,237	298,197	302,867	299,367	295,947	295,197
Median	82,116	80,581	86,836	95,187	103,709	120,728	204,058	252,305	288,854	292,946	291,906	185,056
Minimum	28,767	29,502	39,197	36,703	29,147	52,885	60,367	43,897	77,997	76,823	37,605	29,869
Lake Cascade												
Maximum	622,700	653,811	674,481	644,936	580,614	601,642	673,900	708,768	717,800	711,148	696,688	662,779
Median	439,820	446,253	453,186	445,129	442,975	426,801	436,832	506,952	667,060	675,987	583,081	491,700
Minimum	213,830	224,150	243,870	265,350	294,580	274,000	262,800	264,900	363,800	308,500	241,900	209,100
Deadwood Reservoir												
Maximum	127,000	131,479	136,185	137,576	130,614	130,529	145,211	171,040	172,250	170,380	163,790	126,102
Median	67,688	72,925	77,235	82,817	88,114	92,447	96,115	109,684	154,379	151,109	100,996	70,126
Minimum	0	3,860	15,530	21,630	32,560	39,050	53,190	69,572	78,750	55,670	0	0
Beulah Reservoir												
Maximum	36,252	40,466	47,540	52,000	60,388	60,190	61,461	61,059	60,577	59,349	47,956	36,548
Median	12,628	15,720	19,744	24,333	28,595	39,310	56,692	56,896	51,987	37,941	22,998	14,639
Minimum	0	1,242	3,849	7,043	10,490	13,716	19,763	7,042	185	0	0	0

Table C-2. Historical maximum, median, and minimum streamflows below Federal dams (1971 to 2003).

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake Outflow (Snake River near Moran gage)												
Maximum	2,852	1,590	826	1,200	1,530	3,500	6,050	8,880	11,700	9,030	6,000	6,690
Median	452	402	405	416	414	430	451	2,510	3,545	2,520	2,500	2,149
Minimum	151	138	144	140	86	89	78	191	177	198	935	180
Palisades Reservoir Outflow (Snake River near Irwin gage)												
Maximum	8,870	8,160	6,000	7,470	13,100	16,400	17,400	21,400	40,300	22,900	13,300	12,452
Median	3,210	1,810	1,810	2,250	2,005	2,100	6,105	12,000	13,758	13,458	8,600	6,847
Minimum	873	700	699	692	571	556	556	1,220	7,116	7,110	4,177	2,280
American Falls Reservoir Outflow (Snake River at Neeley gage)												
Maximum	14,500	14,600	12,900	15,200	19,900	22,100	26,100	29,900	46,000	26,800	16,500	16,300
Median	3,020	1,960	2,880	3,970	2,310	3,240	8,840	11,643	12,800	12,600	11,500	7,645
Minimum	239	114	177	187	201	280	720	3,870	6,800	8,290	2,320	1,570
Minidoka Reservoir Outflow (Snake River near Minidoka Dam gage)												
Maximum	15,600	14,400	13,600	15,400	20,000	20,697	24,700	27,900	42,700	25,400	14,700	14,800
Median	3,190	2,710	3,210	4,036	2,665	2,750	8,605	9,240	9,545	9,680	9,180	6,390
Minimum	329	333	87	84	303	362	408	2,720	6,030	7,335	1,357	1,262
Milner Dam Outflow (Snake River at Milner gage)												
Maximum	15,700	14,200	13,800	16,322	20,079	20,656	21,400	19,700	30,919	17,064	7,091	7,156
Median	1,010	2,165	3,320	3,980	2,570	2,800	5,455	2,685	1,105	482	480	461
Minimum	0	2	216	232	157	5	1	1	1	0	0	0

Table C-2. Historical maximum, median, and minimum streamflows below Federal dams (1971 to 2003), continued.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir Outflow (South Fork Boise River gage)												
Maximum	1,140	1,550	1,590	3,020	3,040	3,050	3,880	7,890	7,820	3,970	2,760	1,730
Median	300	302	306	310	316	318	615	1,530	1,700	1,530	1,204	526
Minimum	23	139	191	189	130	97	99	121	551	278	172	122
Lucky Peak Reservoir Outflow (Boise River near Boise gage)												
Maximum	4,600	2,000	3,500	6,950	7,030	7,810	10,600	10,848	13,200	10,500	4,850	4,600
Median	204	156	242	238	272	1,190	3,014	4,710	4,585	4,450	4,150	3,000
Minimum	0	0	2	28	90	8	92	2,210	2,190	2,310	400	217
Lake Cascade Outflow (North Fork Payette River at Cascade gage)												
Maximum	2,300	1,700	2,230	3,780	3,820	4,880	2,980	4,780	6,970	5,560	2,980	3,050
Median	214	216	272	287	237	265	615	692	1,310	1,310	1,730	1,535
Minimum	16	14	122	125	118	110	127	23	127	155	236	134
Deadwood Reservoir Outflow (Deadwood River below Deadwood Dam gage)												
Maximum	769	100	509	526	1,300	750	900	2,220	2,200	1,720	1,650	1,600
Median	3	3	3	3	3	3	4	53	490	709	765	73
Minimum	0	0	0	0	1	1	1	1	1	4	2	0
Beulah Reservoir Outflow (North Fork Malheur River at Beulah gage)												
Maximum	233	10	10	520	2,060	1,630	1,458	1,330	1,110	490	450	374
Median	1	0	0	0	1	2	229	327	305	297	238	102
Minimum	0	0	0	0	0	0	0	4	8	40	26	0
Brownlee Reservoir Inflow (Brownlee Reservoir gage)												
Maximum	31,036	30,686	61,375	70,250	84,721	75,671	84,244	90,600	66,930	41,701	21,631	22,536
Median	14,133	14,855	16,174	17,405	18,605	22,775	28,049	26,151	20,512	10,204	10,834	12,828
Minimum	7,003	9,193	6,739	8,187	6,931	8,106	5,300	5,474	4,674	4,172	4,941	5,808

Table C-3. Historical record of water provided for salmon flow augmentation (in acre-feet) from 1991 to 2004.

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [1]
Snake River above Milner Dam														
Reclamation Space	15,000	0	206,617	285,954	22,396	22,396	22,396	22,896	21,824	22,896	4,717	0	0	0
Rentals, Water Dist. 01	84,000	0	65,000	44,325	232,839	194,667	202,104	200,325	148,397	162,325	0	0	0	0
Rentals, Tribes	—	0	0	0	0	0	0	0	38,000	38,000	36,724	0	0	0
Subtotal	*99,000*	*0*	*271,617*	*330,279*	*255,235*	*217,063*	*224,500*	*223,221*	*208,221*	*223,221*	*41,441*	*0*	*0*	*0*
Snake River below Milner Dam (Snake River High Lift Pumpers [2])														
Idaho Rentals	0	0	0	0	0	0	0	0	0	0	0	37,889	43,135	115,660
Oregon Rentals	0	0	0	0	0	0	0	0	0	0	0	9,600	0	50,000
Subtotal	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*47,489*	*43,135*	*165,660*
Boise River Basin														
Reclamation Space	0	0	23,000	35,950	25,000	38,000	38,000	40,932	40,932	40,932	0	60,198	58,628	41,700
Rentals	0	0	0	0	2,000	0	2,000	0	0	0	0	0	0	0
Subtotal	*0*	*0*	*23,000*	*35,950*	*27,000*	*38,000*	*40,000*	*40,932*	*40,932*	*40,932*	*0*	*60,198*	*58,628*	*41,700*
Payette River Basin														
Reclamation Space	28,874	90,000	95,000	61,883	94,242	95,000	95,000	95,000	95,000	95,000	30,000	110,000	110,000	115,510
Rentals	73,651	0	34,971	0	50,758	56,300	60,000	50,000	65,000	50,000	0	50,000	54,500	0
Subtotal	*102,525*	*90,000*	*129,971*	*61,883*	*145,000*	*151,300*	*155,000*	*145,000*	*160,000*	*145,000*	*30,000*	*160,000*	*164,500*	*115,510*
Lemhi River Basin														
Rentals	0	0	0	0	0	0	0	0	0	0	1,000	1,000	1,000	1,000
Oregon Natural Flows														
Skyline Farms	0	0	0	0	0	15,714	17,649	17,649	17,649	17,649	17,649	17,649	17,649	17,649
Oregon Water Trust	0	0	0	0	0	64	132	198	198	198	198	198	198	198
Subtotal	*0*	*0*	*0*	*0*	*0*	*15,778*	*17,781*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*	*17,847*
Total	**201,525**	**90,000**	**424,588**	**428,112**	**427,235**	**422,141**	**437,281**	**427,000**	**427,000**	**427,000**	**90,288**	**286,534**	**285,110**	**341,717**

1 Projected as of September 2004.

2 Reclamation entered into an agreement with IDWR to lease natural flows from high lift pumpers between Milner Dam and King Hill. IDWR monitors compliance to ensure that crops are taken out of production. IDWR is still verifying final volumes.

Table C-4. Historical record of Reclamation storage sources used for salmon flow augmentation.

Reclamation Space	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004 [1]
Snake River above Milner Dam (Minidoka, Palisades, and Ririe Projects)														
American Falls Reservoir	—	—	0	0	8,951	8,951	8,951	8,951	8,884	8,951	4,717	0	0	0
Jackson Lake	—	—	0	0	3,923	3,923	3,923	3,923	3,795	3,923	0	0	0	0
Palisades Reservoir	—	—	13,615	15,754	9,522	9,522	9,522	10,022	9,145	10,022	0	0	0	0
Palisades Dam powerhead	—	—	18,794	153,530	0	0	0	0	0	0	0	0	0	0
Minidoka Dam powerhead	—	—	95,575	99,240	0	0	0	0	0	0	0	0	0	0
Ririe Reservoir	—	—	78,633	17,430	0	0	0	0	0	0	0	0	0	0
Subtotal	*15,000* [2]	*0*	*206,617*	*285,954*	*22,396*	*22,396*	*22,396*	*22,896*	*21,824*	*22,896*	*4,717*	*0*	*0*	*0*
Boise Project, Arrowrock Division														
Anderson Ranch Reservoir	—	—	0	0	3,000	3,000	3,000	0	0	0	0	0	0	0
Anderson Ranch Reservoir (inactive space)	—	—	20,000	10,950	0	0	0	0	0	0	0	36,260	0	0
Lucky Peak Reservoir	—	—	3,000	25,000	22,000	35,000	35,000	40,932	40,932	40,932	0	23,938	58,628	41,700
Subtotal	*0*	*0*	*23,000*	*35,950*	*25,000*	*38,000*	*38,000*	*40,932*	*40,932*	*40,932*	*0*	*60,198*	*58,628*	*41,700*
Boise Project, Payette Division														
Lake Cascade	—	—	69,600	26,845	68,842	69,600	69,600	69,600	69,600	69,600	0	69,600	69,600	69,600
Deadwood Reservoir	—	—	25,400	35,038	25,400	25,400	25,400	25,400	25,400	25,400	30,000	40,400	40,400	46,060
Subtotal	*28,874* [2]	*90,000* [2]	*95,000*	*61,883*	*94,242*	*95,000*	*95,000*	*95,000*	*95,000*	*95,000*	*30,000*	*110,000*	*110,000*	*115,660*

1 Projected as of September 2004.
2 Exact sources not tracked prior to 1993.

Appendix D MODELED HYDROLOGIC DATA

Table D-1 and Table D-2 show the modeled maximum, median, and minimum end-of-month reservoir contents and outflows if all the proposed actions are implemented. These tables only provide information for river reaches and reservoirs where there may be issues with ESA-listed species.

Table D-1. Modeled proposed actions maximum, median, and minimum end-of-month reservoir contents at Federal reservoirs. (Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**
Jackson Lake (reservoir contents do not reflect an unquantified natural lake volume)												
Maximum	659,539	666,677	681,277	698,003	699,903	649,903	724,978	847,008	847,008	847,008	750,007	697,077
Median	635,096	638,167	647,002	646,003	645,765	627,753	592,325	730,029	847,003	800,004	716,948	635,256
Minimum	0	5,509	15,309	27,609	32,509	41,809	70,472	221,030	508,205	336,298	57,254	0
Palisades Reservoir												
Maximum	1,300,002	1,300,002	1,300,002	1,336,903	1,400,001	1,400,001	1,400,001	1,400,002	1,400,008	1,400,008	1,300,007	1,300,002
Median	1,083,636	1,179,094	1,259,200	1,180,844	1,166,449	1,058,005	1,094,613	1,178,321	1,400,003	1,319,562	1,190,537	1,036,006
Minimum	139,810	200,201	249,701	287,401	314,201	353,301	300,007	612,025	902,544	454,118	200,201	118,554
American Falls Reservoir												
Maximum	1,200,001	1,300,000	1,500,001	1,400,004	1,500,003	1,672,592	1,672,598	1,672,598	1,672,598	1,600,007	1,400,007	1,259,170
Median	420,081	753,500	1,029,940	1,223,554	1,379,834	1,550,353	1,627,703	1,671,415	1,672,593	1,035,545	472,378	380,506
Minimum	85,366	260,489	410,367	649,046	843,794	1,065,082	874,945	443,654	100,356	0	0	50,178
Lake Walcott												
Maximum	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Median	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Minimum	171,000	151,000	151,000	151,000	171,000	205,000	210,200	210,200	210,200	210,200	210,200	210,200
Arrowrock Reservoir [1]												
Maximum	150,000	180,002	230,007	233,987	242,564	281,967	286,608	286,608	286,607	286,608	201,997	216,713
Average	114,644	147,999	190,500	160,781	161,650	221,800	247,822	274,796	286,604	227,995	114,604	97,132
Minimum	28,661	29,135	54,935	57,322	28,661	56,700	28,661	114,644	28,661	28,661	28,661	28,075

1 Capacity does not reflect recent sedimentation survey from 1997, 1998 or 2002.

Table D-1. Modeled proposed actions maximum, median, and minimum reservoir contents at several reservoirs by month, continued. (Table reflects total capacity including active, inactive, and dead storage)

Location	Reservoir Contents (acre-feet)											
	Oct	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sept**
Anderson Ranch Reservoir [1]												
Maximum	463,766	464,502	448,990	435,071	424,578	413,684	442,985	493,186	493,190	493,191	461,148	464,469
Median	353,928	357,476	361,028	353,928	3392328	330,865	364,175	450,506	493,186	432,488	386,814	373,405
Minimum	52,432	56,432	61,132	65,932	69,833	69,833	119,056	150,489	69,833	49,408	49,408	49,408
Lucky Peak Reservoir												
Maximum	148,769	148,769	168,767	219,625	266,142	268,846	288,567	293,025	293,024	293,025	293,025	262,373
Median	128,767	138,767	138,767	158,383	186,725	211,857	228,119	266,600	293,021	293,021	247,719	154,431
Minimum	28,767	55,193	58,193	68,180	93,116	128,574	108,767	175,000	205,117	85,584	28,7670	28,767
Lake Cascade												
Maximum	566,669	604,227	566,664	557,120	553,392	561,165	611,552	693,125	693,130	693,129	620,675	586,665
Median	492,053	507,109	518,635	504,270	505,171	512,799	570,988	661,198	693,126	638,218	530,365	482,866
Minimum	293,936	297,661	303,797	301,880	300,021	316,112	389,187	421,478	461,516	366,532	293,936	293,936
Deadwood Reservoir [1]												
Maximum	123,376	130,000	135,000	129,320	131,727	133,204	146,267	162,003	162,008	160,007	130,006	120,006
Median	73,227	77,100	80,100	81,680	83,290	88,726	99,284	135,857	162,004	115,619	79,339	71,140
Minimum	46,621	46,831	47,931	47,901	47,191	49,551	58,122	81,005	64,804	50,001	47,481	46,671

1 Capacity does not reflect most recent sedimentation surveys from 1997, 1998 or 2002.

Table D-2. Modeled proposed actions maximum, median, and minimum streamflows (reservoir outflows) at several river gages by month.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Jackson Lake Outflow (Snake River near Moran gage)												
Maximum	976	840	651	651	651	735	2,879	6,831	7,076	5,083	5,334	3,546
Median	336	304	390	468	507	392	710	1,952	3,892	2,762	2,542	2,218
Minimum	273	282	273	273	292	273	282	293	807	1,654	976	1,008
Palisades Reservoir Outflow (Snake River near Irwin gage)												
Maximum	6,545	4,736	3,872	7,439	8,236	8,631	18,570	18,028	30,284	19,849	12,686	11,871
Median	3,065	1,465	1,073	2,773	2,555	2,572	5,917	10,837	14,697	11,368	8,654	6,496
Minimum	1,756	958	927	927	991	927	1,109	3,911	8,105	8,420	6,357	4,033
American Falls Reservoir Outflow (Snake River at Neeley gage)												
Maximum	9,323	11,399	7,498	14,143	12,174	12,167	22,935	24,531	34,440	17,970	15,614	10,982
Median	3,299	2,017	1,952	3,402	3,617	4,305	7,313	11,655	11,936	12,841	11,517	7,622
Minimum	835	202	195	195	417	342	2,864	7,470	8,796	8,742	6,733	2,751
Lake Walcott Outflow (Snake River near Minidoka Dam gage)												
Maximum	9,992	11,320	8,372	14,288	12,141	11,887	23,140	22,796	31,345	16,064	13,676	9,718
Median	3,537	2,421	2,046	3,601	3,474	3,836	6,554	10,597	9,667	10,389	9,462	6,362
Minimum	1,343	580	133	224	277	60	2,510	6,025	7,151	7,668	5,274	2,128
Milner Dam Outflow (Snake River at Milner gage)												
Maximum	6,536	11,982	8,422	15,160	12,453	11,754	20,075	15,468	22,554	7,347	5,729	3,903
Median	488	2,498	2,247	3,756	3,580	3,677	3,730	4,204	2,283	1,833	1,501	303
Minimum	195	488	390	488	522	146	202	149	5	5	5	5

Table D-2. Modeled proposed actions maximum, median, and minimum streamflows (reservoir outflows) at several river gages by month, continued.

Location	Streamflow (cfs)											
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept
Anderson Ranch Reservoir Outflow (South Fork Boise River gage)												
Maximum	1,038	810	719	1,930	3,241	2,927	4,852	3,868	3,692	2,244	1,561	504
Median	390	303	293	293	324	480	1,478	1,561	1,875	1,561	976	504
Minimum	122	126	122	122	157	293	504	585	1,613	521	114	131
Lucky Peak Reservoir Outflow (Boise River near Boise gage)												
Maximum	3,539	949	2,518	6,184	6,847	6,864	10,083	9,758	8,090	5,775	4,597	3,516
Median	1,179	202	234	669	741	915	4,599	5,583	5,353	4,081	3,951	3,235
Minimum	475	81	78	78	86	98	768	2,746	3,716	2,923	1,364	452
Lake Cascade Outflow (North Fork Payette River at Cascade gage)												
Maximum	1,073	3,025	1,783	2,440	3,161	1,952	2,929	3,462	4,918	2,196	2,196	1,480
Median	293	222	215	340	359	391	539	1,254	1,904	1,403	1,890	1,036
Minimum	82	202	195	195	156	195	202	215	807	1,064	1,339	283
Deadwood Reservoir Outflow (Deadwood River below Deadwood Dam gage)												
Maximum	67	60	101	266	294	340	1,062	962	968	1,013	1,208	252
Median	49	50	49	49	54	49	50	114	501	624	817	50
Minimum	49	50	49	49	52	49	50	49	202	98	49	50
Brownlee Reservoir Inflow (Brownlee Reservoir gage)												
Maximum	22,655	26,858	26,391	48,543	48,843	64,610	81,463	67,572	57,980	25,034	17,240	17,868
Median	13,752	15,579	14,980	17,260	18,630	19,942	27,822	27,619	24,049	12,542	11,537	11,878
Minimum	9,128	10,751	9,711	10,119	8,184	10,621	8,906	8,592	7,748	6,423	5,350	6,864

This version of the biological assessment does not contain the CD-ROM containing Pisces or the model results.

Appendix E THE UPPER SNAKE RIVER MODSIM MODEL

Reclamation used the Upper Snake River MODSIM model (version date 7/13/04) to simulate project operations under the proposed actions. Reclamation then used the modeled output to evaluate the hydrologic effects of the proposed actions on ESA-listed species in the action areas. MODSIM is a general purpose river and reservoir operations computer simulation model. Colorado State University and Reclamation jointly developed the model.

The following is a list of items on the enclosed CD-ROM with additional information about how to use the feature or where to access the information. Before accessing any of the CD-ROM's files, first copy the contents onto the computer's hard drive.

E.1 *Pisces*

This software acts as the general user interface for the data contained on the CD-ROM. After copying the CD-ROM's contents onto the hard drive, run the pisces.exe application. Clicking "Help!" on the *Pisces* menu bar will open an HTML file in the browser entitled "How to View Model Output Using Pisces." This page contains helpful information for viewing and manipulating data from the CD-ROM.

Through this interface, a user can view the following modeled output as tables or graphs:

- time series data for river flows and reservoir contents and elevations (a time series is a hydrograph for the period of record)
- exceedance data for river flows and reservoir contents and elevations (an exceedance curve shows how often a river reach or reservoir equals or exceeds a specific flow or volume)

The data are output as monthly flows or end-of-month reservoir contents or elevations.

E.2 Model Description

Since 1992, Reclamation and Colorado State University (CSU) have jointly enhanced the MODSIM river simulation model in order to address various river system operation analyses requirements. Early emphasis on water rights, storage allocation, water banking/rental pool, and water exchange accounting was very successful in developing a procedure that allows integration of simulation of very complex large scale physical river systems and, optionally, detailed water rights/entitlements accounting. More recently, efforts have been made to streamline the use of groundwater response functions as an option for analyzing conjunctive management practices. Most recently, the MODSIM model and user interface have been ported to the .NET software platform to allow for a wider audience of users and enhancements for the "scripting" capability (used to create customized basin specific models).

MODSIM uses a state-of-the-art Lagrangian Relaxation network flow cost minimization procedure to simulate an "optimized" distribution of water in the river system for each of a series of time steps. Linear equations represent the river topology mass balance constraints and the objective function of minimizing the "cost" of the flow that will flow through all links in the network. The modeler (through a user interface) creates a data set for the model in terms of the river system physical features (reservoir area, capacity, elevation tables; location of local gains; diversion location and temporal distribution; etc), the operational considerations (for example, meeting a flow objective below Palisades Dam of 1,100 cfs or 1,500 cfs, depending on forecasted runoff), and, optionally, water rights and storage allocation constraints.

The Snake River data set for MODSIM represents major river, reservoir, and water demand features of the Snake River upstream from Brownlee Reservoir. Many of the smaller tributaries are modeled as a single local gain; some tributaries, such as the Malheur and Wood Rivers have separate model data sets that can generate sub-basin simulation for inclusion with the main Snake River data set.

Simulation results are expressed in terms of anticipated monthly volume river flows, irrigation diversions, and end-of-month reservoir contents. Where applicable, other output includes reservoir evaporation, seepage, power generation, groundwater pumping, depletion, return flows, and consumptive and nonconsumptive demand shortage. In addition, if the basin model uses MODSIM's water allocation constructs, model output includes reservoir priority accrual, natural flow diversion at each demand, storage contract accrual, carryover, use, and rental pool activity.

E.3 Modeling River System Features

In the simulations, river reaches, reservoirs, diversion "groups," and other major features of the Snake River were originally taken from "planning" models from the Idaho Department of Water Resources (IDWR). These models were used to complete analysis for many long-term operation proposals before the Upper Snake River

MODSIM model was developed. Data from various sources has since replaced and augmented that obtained from the IDWR model data sets.

River reaches are designated by long-term river gage locations; some of the river gages have been introduced since 1928 (the first year of the temporal period of record simulated); some river gages that were in existence through many years of the period of record have been discontinued. Usually, if a gage location has an important operational consideration and is currently being used, the gage is modeled; if a discontinued gage has a long period of historical record and is used in developing model parameters such as return flows, these gages are many times retained in the model. If a historical gage location is not used operationally and water budgets for model parameter derivation can be produced without reference to the discontinued gage, the gage is not modeled. Operation flow objectives are modeled for 31 river reaches in the Snake River 2004 biological assessment data set. Flow objectives are modeled as nonconsumptive demands. Some of the flow objectives are for aquatic life support, fish and wildlife considerations, river head maintenance for diversion capability, recreation, and flood control objectives. Many flow objectives are multi-purpose. Some trans-basin diversions, such as Reservation Canal and Eagle Rock, are modeled as nonconsumptive diversions similar to flow objective demands.

Diversion "group" nodes represent one or more diversion demands combined out of convenience for modeling purposes. If one can reasonably assume that model parameters (such as return flow coefficients) can be shared by diversions in the same proximity from modeled river gages, then one can safely combine the diversions. If the diversions must be analyzed to account for their own unique parameters or constraints (such as water rights), then the diversions should be modeled separately. Natural flow water rights were obtained from IDWR files used in their water rights allocation models of the Idaho Water Districts. Storage contracts are from Reclamation files. Each natural flow right and storage contract, along with rent pool agreements, are modeled with individual links from a river node to the demand node. The Snake River 2004 biological assessment data set analyses have 103 irrigation diversion groups. The following sections list the diversion groups by sub-basin; the last section describes reservoirs.

E.3.1 Henrys Fork

Abv_Asht	Yellow-M	Sqrl-Che	Farm_Own	Enterpri
Fall_Riv	Chest_Cu	Fall_R_C	Last_Cha	StAnth_U
Asht-StA	FarmFr_S	Egin_Ind	Consol_F	Abv_StAn
Siddoway	MiscTt	Wilford	Teton_Is	RexburgC
Dewey				

E.3.2 Snake above AMF

Wyom_Irr	Abv_Heis	Riley	Heis-Lrz	Anderson
FarmF-En	Harrison	Burgess	LowerDry	Sunnydel
LrzIFall	ButteMrk	Osgood	GreatWes	Idaho
AbTexDiv	BlwRRdiv	SandCDiv	BlwSandC	SnkRivVa
IFallShy	Woodville	ShyBlkft	BlkftCor	NewLavas
PeopAber	FortHall	Parsons		

E.3.3 Snake AMF-Milner

FallsID	NlyMndka	MindkInc	MndkaMil	SSideTwi
A_BPump	MilGood	NorthSid	MilLowLi	BurleyID

E.3.4 Snake below Milner

RaftRive	LowLine	SalFallC	BellRapi	BlackMes
KngHlPP	MiscKH_S	CJPPdiv	CJMurpDi	SnakeRID
GrandvID	GrandMut	KngHillP	Owydown	OWCO
599	710	720		

E.3.5 Boise

Sebree	Riversid	Eureka2	Nots_Par	Settlers
ThurmanM	FarmersU	9EagleIs	NEagleIs	CanyonCn
Phyllis	CaldwHig	NewYork	DeerFlat	Ridenbau
BubbBois	Penitent			

E.3.6 Payette

SsBlkCan	NsBlkCan	640	655	660_670
NFStorRt				

E.3.7 System Reservoirs

Reservoirs modeled are those that have significant impact on the physical flows in the river system or accounting for water use entitlement. Area, capacity, elevation, and hydraulic capacity data are obtained from Standard Operating Procedures, design drawings, HYDROMET tables, and personal contact with operation agency personnel. Eighteen reservoirs are modeled in the Snake River 2004 biological assessment data set. Listed below are the 18 reservoirs with their modeled maximum contents.

Cbtt Name	Acre-feet	Cbtt Name	Acre-feet
GRS	15,200	HEN	90,400
ISL	135,000	JCK	847,000
PAL	1,400,000	BLK	350,000
AMF	1,672,590	MIN	210,200
RIR	80,500	OWY	735,000
CSC	646,461	DED	162,000

PAY	35,000	EMM	30,880
AND	464,200	ARK	286,600
LUC	264,250	LOW	159,400

E.4 Snake River Water Supply Gains and Demands

A critical element of this analysis is the derivation of a data set of past river gains modified to the year 2000 level of irrigation. Period of record (from 1928 to 2000) water supply gains and diversion demand are computed for the Snake River basin upstream from Brownlee Dam. Previous analyses were performed using a 1928-1989 data set modified to the year 1989 level of irrigation (Robertson and Sutter 1989). Since 1989, river gains have decreased in some areas and a longer data set was needed which reflected this phenomena. Diversion demand is summarized for the period from 1991 to 2000 and grouped/averaged for dry, average, or wet water supply conditions. These three diversion patterns are considered to be water year 2000 development level and will be used in modeling analyses to represent anticipated diversion demands in near future operation simulation analyses. The water supply gains are in some cases unregulated river gains derived from historical recorded streamflow and diversion data; in some cases unregulated river gains are adjusted by various means to represent a "present condition" influence from groundwater interaction.

E.4.1 Snake River above King Hill

Unregulated local river gains are computed using historical streamflow and diversion records. Streamflow records are obtained from USGS, IDWR and USBR; diversion records are provided by IDWR and Reclamation data bases. Correlations are used to fill in and extend unrecorded data to obtain a complete record from 1928 to 2000. Short term return flow factors are taken from Garabedian (1992). Computations are completed using Excel spreadsheets or, where the reach is complex with return flow computations, small MODSIM networks. The basic mass balance equation is:

Equation 1 Unregulated Local Gain = Downstream gage – Upstream gage + historical diversions – short-term return flow + change in reservoir storage + reservoir evaporation

Reclamation's Science and Technology program sponsored activities to investigate the use of groundwater response functions to quantify the influence of groundwater interaction on river gains in the Snake River upstream from King Hill. Response functions from the East Snake Plain Aquifer groundwater model are supplied in the form of an Access database from Idaho Water Resources Research Institute (IWRRI). Procedures are developed to apply the response functions to areas of historical irrigation practice (see Reclamation's Science and Technology Program Procedures for Conjunctive Management Analyses in the Upper Snake River Basin).

Historical irrigated acreage is taken from Garabedian and IDWR GIS maps. Consumptive use is estimated using the estimated acreage, crop patterns, and historical temperature and precipitation data with a Blaney Criddle method (see Computer Procedure XCons Denver Technical Service Center). MODSIM networks are created with response functions, historical diversions, short-term return flow factors, and consumptive use for 26 surface water irrigation areas per Garabedian and in 21 groundwater diversion zones per IWRRI (see Johnson and Cosgrove 1999) to compute aquifer recharge and the lagged influence in 7 reaches of the Snake River from the surface water recharge and groundwater use. This influence is removed from the unregulated river gains to derive a more naturalized streamflow. The response functions are used with current average surface and groundwater diversions to estimate "steady state present conditions" influence to river gains; these are added to the "naturalized" gains to represent current conditions water supply over the historical period of record. Implicit to the MODSIM networks are the following equations:

Equation 2 Aquifer Recharge = Surface irrigation diversion – consumptive use – short-term return flow

Equation 3 Aquifer Depletion = Groundwater irrigation consumptive use

Equation 4 "Naturalized Local River Gain" = Unregulated local gain – lagged Aquifer Recharge + lagged Aquifer Depletion

Equation 5 "Steady State Present Condition Local River Gain" = "Naturalized Local River Gain" + lagged influence from future surface irrigation diversions – lagged influence from future groundwater irrigation use

Future surface and groundwater diversions, for the above computations, are estimated as the average historical diversions from 1996 to 2000.

E.4.2 Boise River

Spreadsheets and MODSIM networks are used with historical USGS streamflow and IDWR estimated diversion data to derive unregulated local gains for the period of record from 1928 to 2000. Estimated diversion data is based on spotted records of historical data from the mid-1950s, 1977, and more complete records after 1985.

Correlations are used to estimate historical streamflows and river gains where streamflow data was not recorded. Historical return flows are estimated from the IDWR estimated diversion data to match annual volumes of drain data derived as part of the Treasure Valley Hydrologic Project. GIS methods are used to assign diversion infiltration rates for the major diversions.

For the period from 1928 to 1949, significant negative gains result from the use of the historical streamflow, estimated diversion, and return flows in the reach from Boise River at Glenwood to Notus. The computed negative gain is not dependent on the estimated flow at Glenwood (even with zero flow at Glenwood the gain would compute negative) but is dependent on the estimated diversion and return flows in this reach. Anderson Ranch Reservoir filled for the first time in 1951; before this time, diversions patterns were considerably different than after. Rates of diversions and efficiencies changed (rates went up and efficiencies went down) with the added water supply in summer months. The computed gain for this reach is correlated with the flow at Glenwood (estimated flow), which made the computed gain between Glenwood and Notus consistent throughout the period of record. The gain plus return flow from Glenwood to Middleton is estimated as a percent of the total gain plus return flow from the IDWR planning model. The gain from Glenwood to Middleton needs to meet estimated diversions in the reach with the estimated flow at Glenwood. The final gain from Glenwood to Middleton is taken as the maximum of the ratio of the Glenwood to Notus gain and the gain needed to meet estimated diversion. The remainder of the Glenwood to Notus gain is assigned downstream of Middleton. In below average water supply years some small negative gains are computed; these are retained as an adjustment to the static efficiencies assumed in deriving return flows.

E.4.3 Payette River and Snake River downstream of King Hill

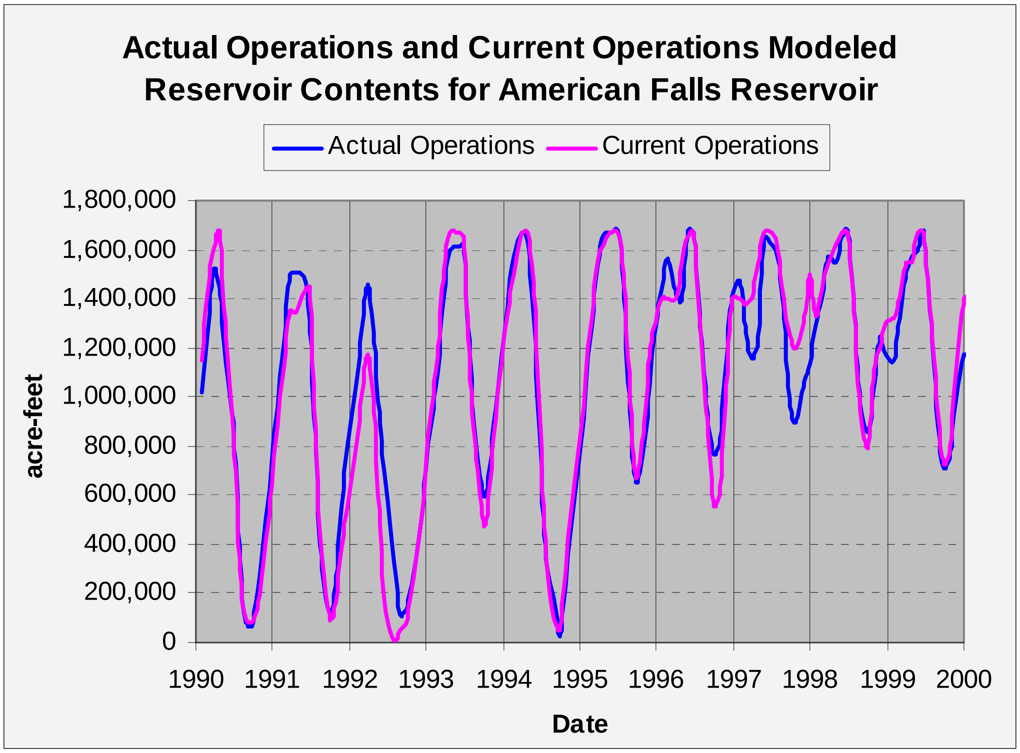
Spreadsheets are used with USGS and Reclamation recorded streamflow data and IDWR recorded/estimated diversion data to compute unregulated local gains for flow points in the existing MODSIM model data set. Return flows on the Snake River are estimated using infiltration and lag factors that originated from IDWR. No return flows were estimated for diversions in the Payette and Owyhee River basins. In many cases, where there are discontinuous records at intermediate river gage locations, a composite gain is computed for a larger area between gages with a complete record and a simple correlation of the smaller area gain to the composite gain is used to disaggregate the larger area gain. No adjustments are made to the unregulated local gains; the gains are assumed to represent the period of record water supply under envisioned modeling studies.

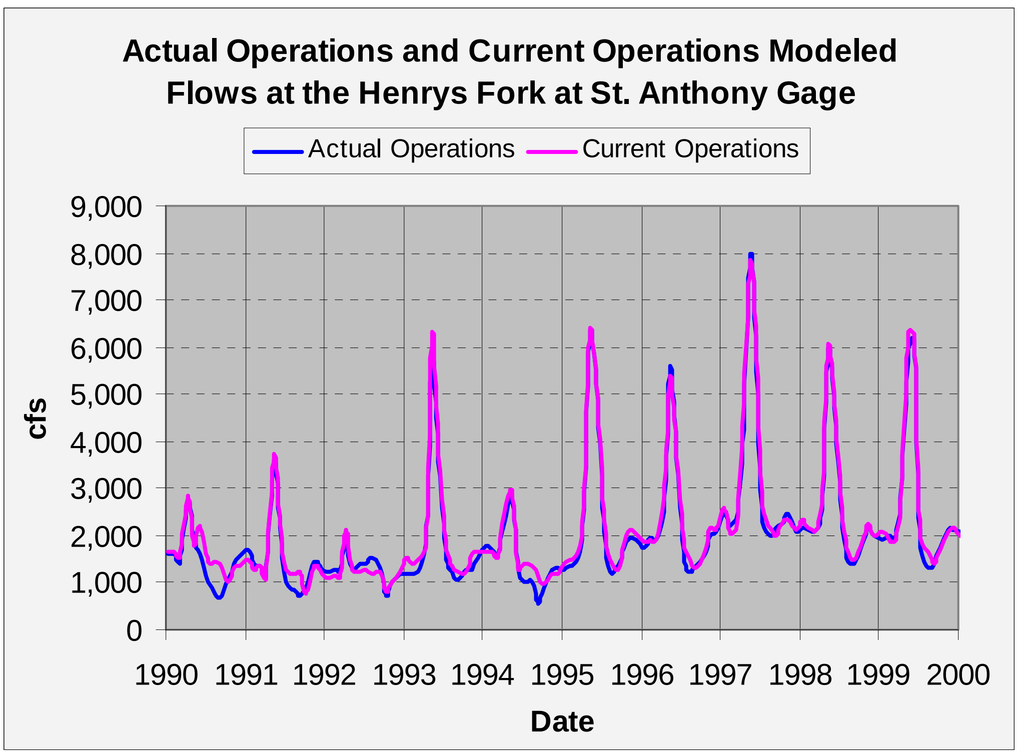
E.5 Modeling Intangibles

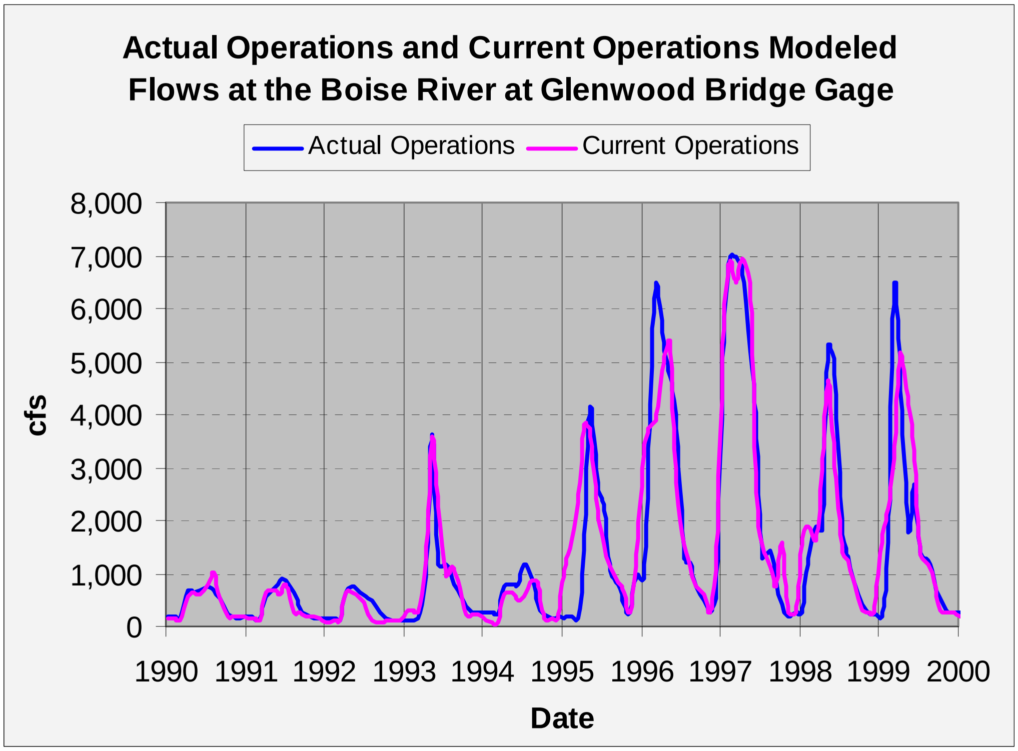
The MODSIM model used in the Snake River 2004 biological assessment attempts to predict near future operations based on the assumption that current practices will continue into the future. Such things as irrigation water demand, minimum flows, and the willingness of spaceholders to contribute to the rental pools can change with economic, political, and scientific conditions. In order to predict what happens in the future, one can attempt to quantify what has happened in the past and relate that to some measurable factor such as the dryness of the river basin or the volume of anticipated runoff. Diversion demand pattern, reservoir target content, flow objective level, and rent pool activity quantities can be dynamically determined in the MODSIM model based on the time step "Hydrologic State." At each time step, a table look-up is completed for any number of sub-basins (three are defined in the Snake River: Upper Snake, Boise, Payette) that determines the designation of water supply conditions (with 1 being very dry and 7 being very wet). There are 7 monthly rule curves defined for each reservoir that specify the desired end of month content based on the Hydrologic State computed for the given time step. Similarly, there are 7 annual diversion volumes (each with a temporal distribution pattern) for each irrigation demand; there are optionally, 7 rent limits for a storage contract. The demand level or rental activity limit is selected at each time step based on the derived Hydrologic State for that time step. Usually the Hydrologic State tables are based on a forecasted runoff at an operational forecast gage location (e.g., Heise, Lucky Peak, or Horseshoe Bend). The forecast may or may not be combined with simulated reservoir contents at specified dams as the basis for the table look-up factors. The Snake River 2004 biological assessment data set uses historical unregulated residual runoff flows January through September for the "forecasted runoff" values. Runoff after June is usually inconsequential to defining the water supply conditions; so values for hydrologic state in July through December are held at values computed for June of a given year.

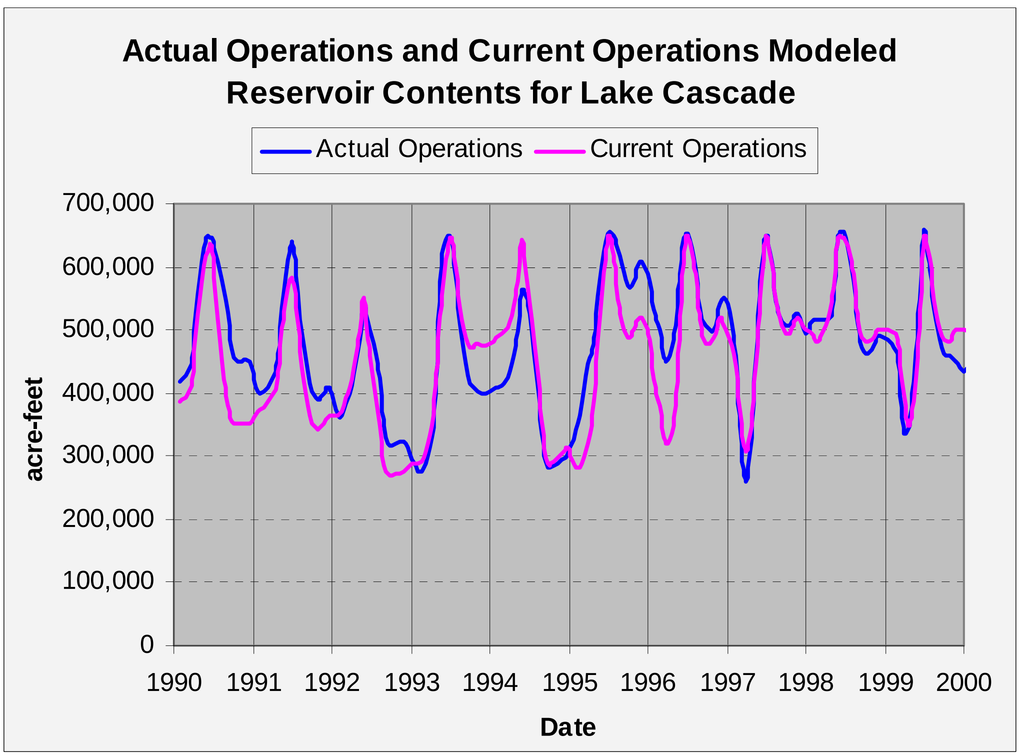
E.6 Validating the Model

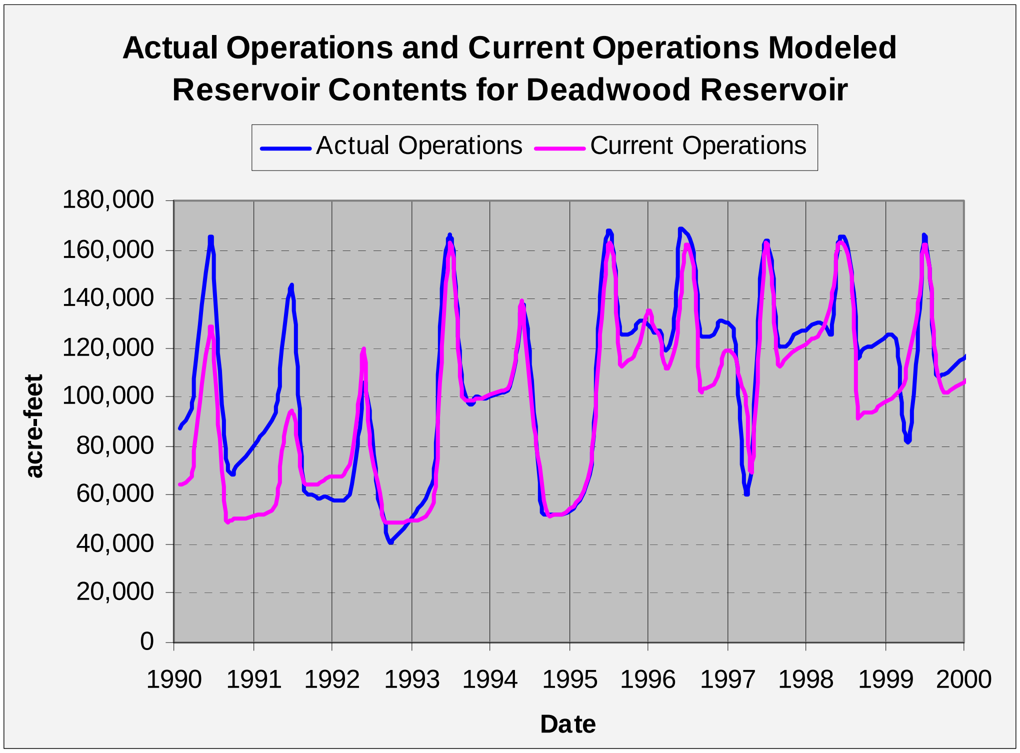
One way to validate the modeling analysis is visually compare modeled results to a period when similar conditions existed. River system features and the historical operational objectives in the mid- and late 1990s in the modeled 2000 Current Operations scenario were very similar to the conditions that existed at the time. In those years (except 1993 and 1994) Reclamation attempted to provide 427,000 acre-feet of flow augmentation without the use of powerhead. The following graphs show historical monthly data as compared to modeled data for the current conditions. Note the similarity except in 1993 and 1994 when powerhead was used to firm up the 427,000 acre-feet. Regressions were completed at three selected locations (Palisades outflow, American Falls Content, and Boise River at Glenwood flow) between historical recorded and simulated values. F test statistics show that the historical and simulated samples for monthly values between 1991 and 2000 are statistically from the same population with over 95 percent confidence. These results are documented in the spreadsheet SelectedRegressions.xls, available from Reclamation's Pacific Northwest Regional Office.

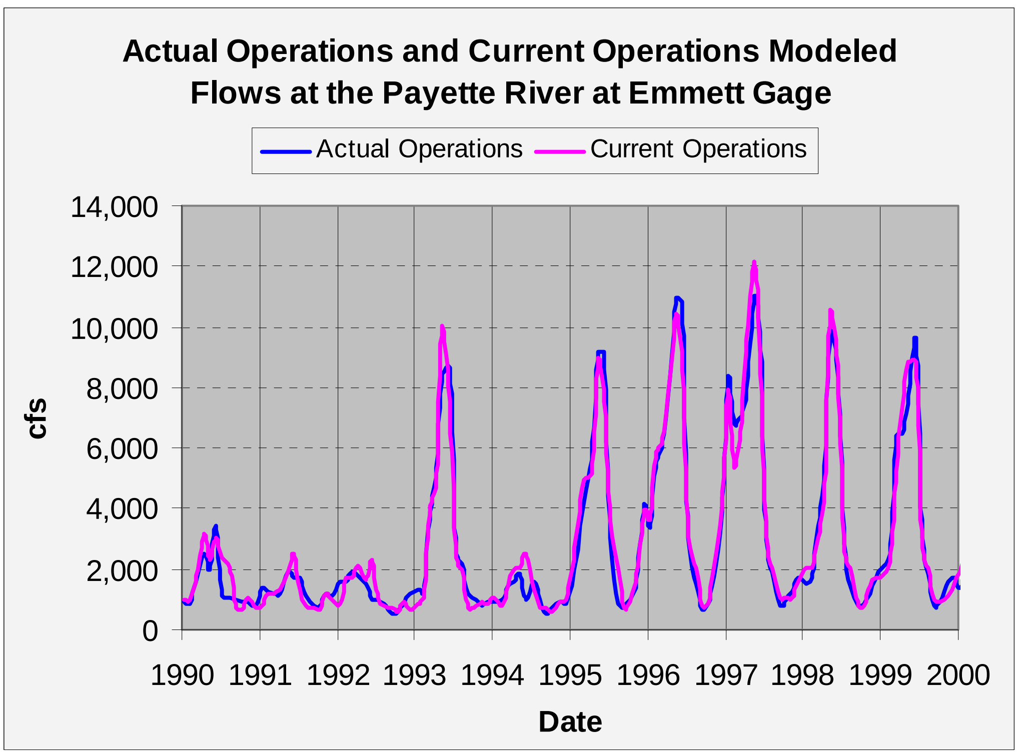


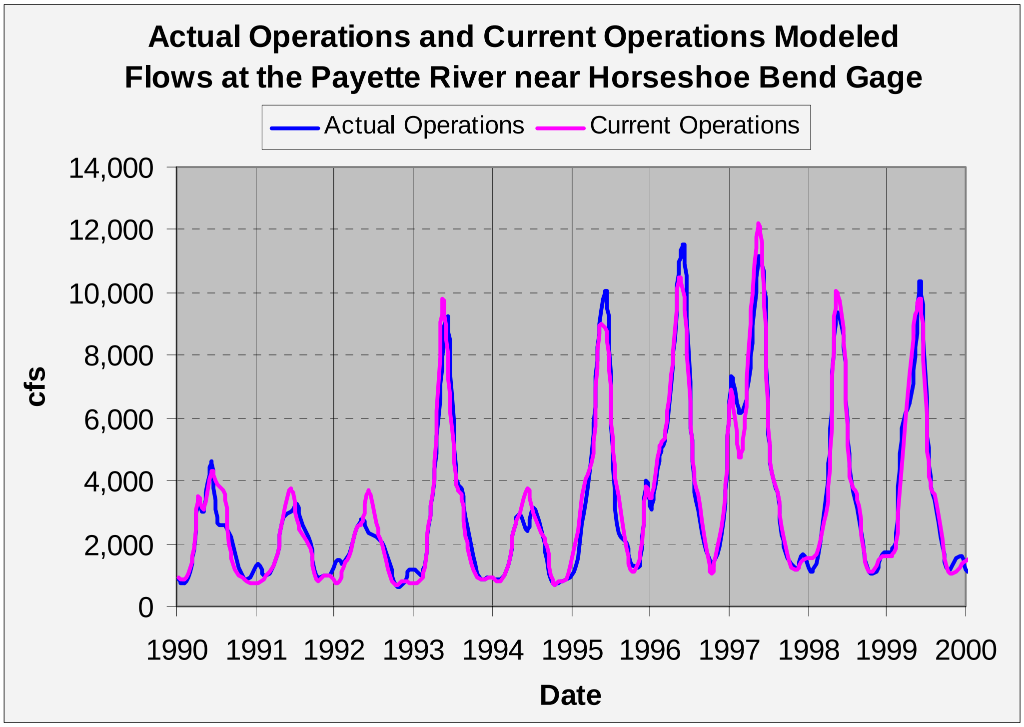


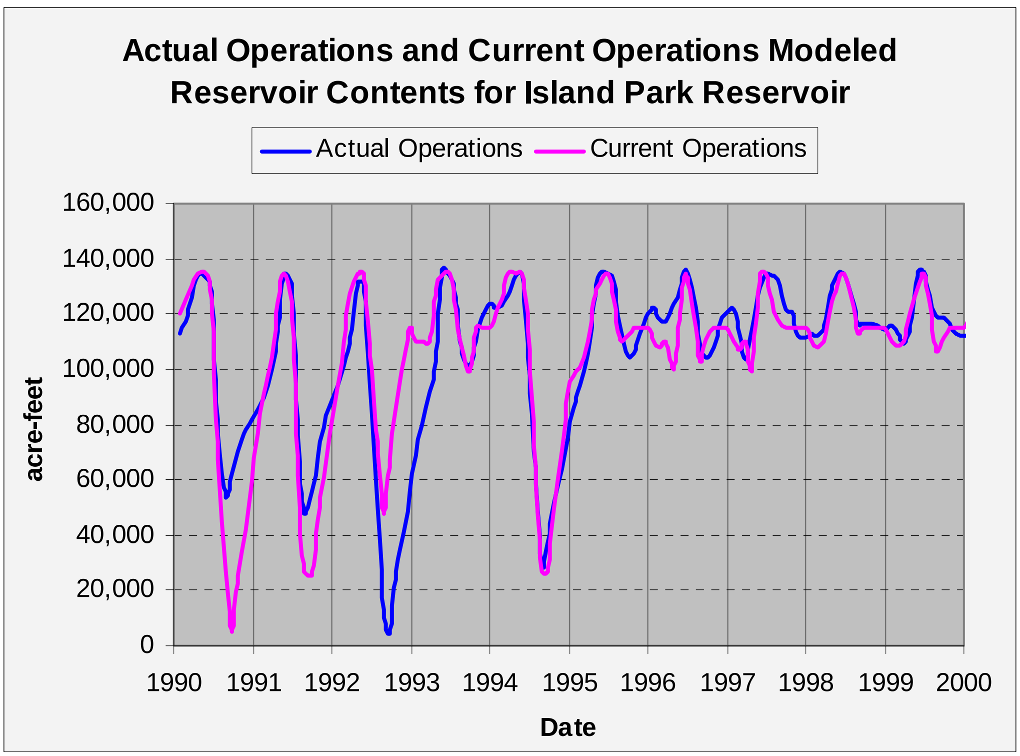

Actual Operations and Current Operations Modeled
Flows at the Boise River at Glenwood Bridge Gage
Actual Operations
Current Operations
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

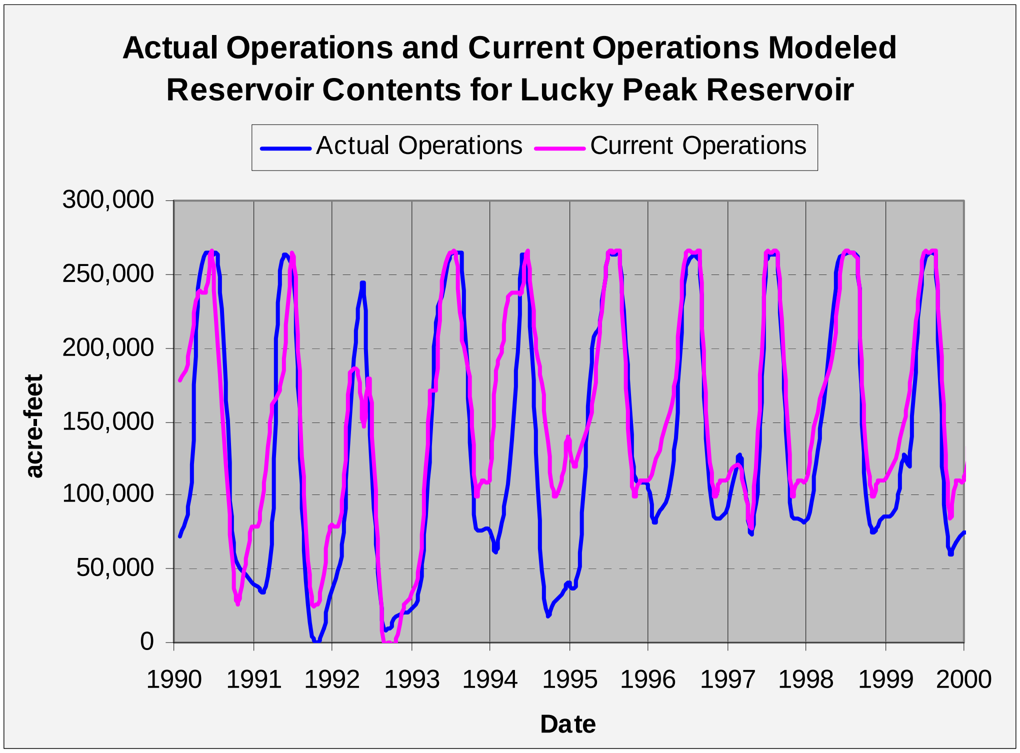

Actual Operations and Current Operations Modeled
Reservoir Contents for Lake Cascade
Actual Operations
Current Operations
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
acre-feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

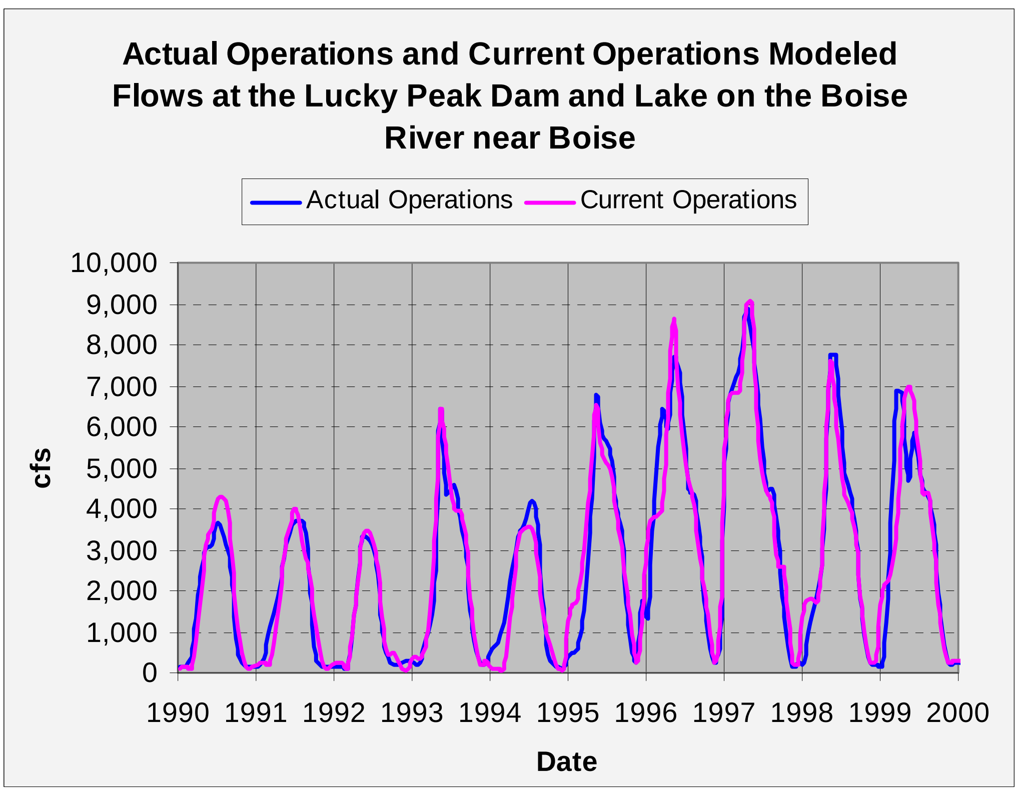

Actual Operations and Current Operations Modeled
Reservoir Contents for Deadwood Reservoir
Actual Operations
Current Operations
180,000
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
acre-feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Payette River at Emmett Gage
Actual Operations
Current Operations
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Payette River near Horseshoe Bend Gage
Actual Operations
Current Operations
cfs
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Island Park Reservoir
Actual Operations
Current Operations
acre-feet
160,000
140,000
120,000
100,000
80,000
60,000
40,000
20,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Lucky Peak Reservoir
Actual Operations
Current Operations
acre-feet
300,000
250,000
200,000
150,000
100,000
50,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Lucky Peak Dam and Lake on the Boise
River near Boise
Actual Operations
Current Operations
cfs
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
1990
1991
1992
1993
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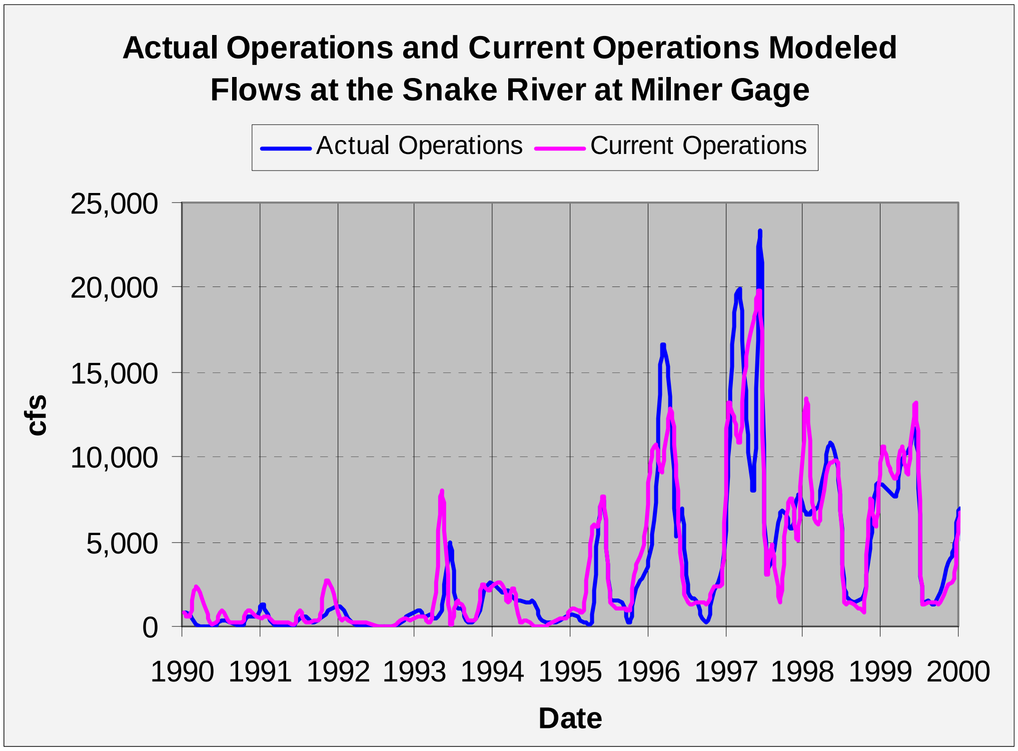
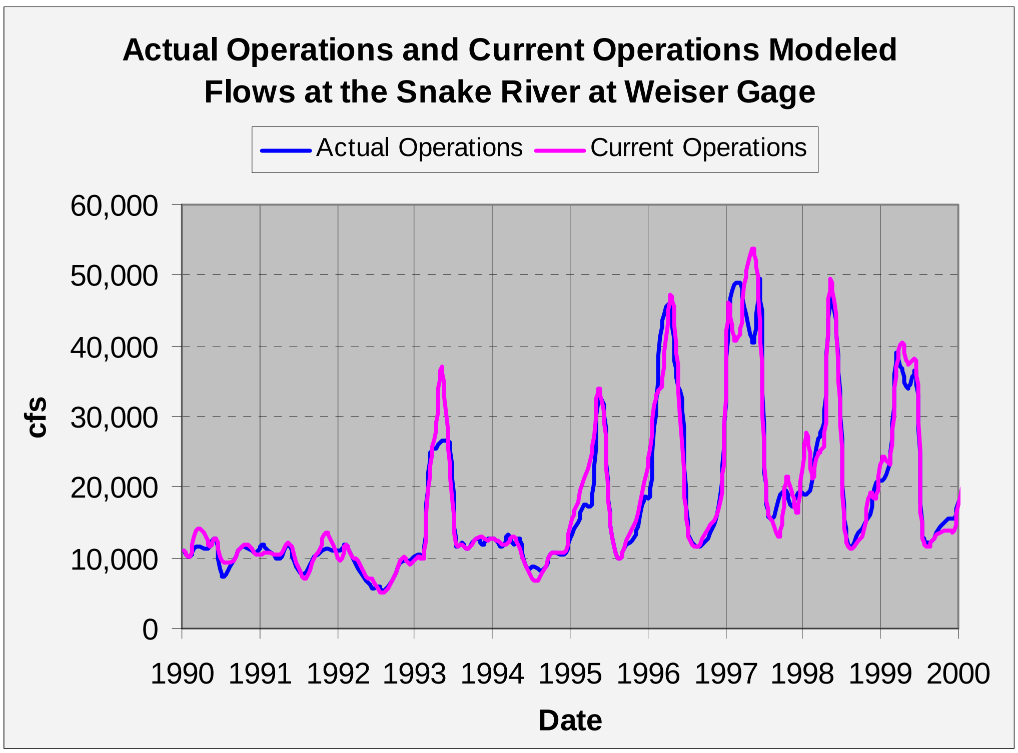
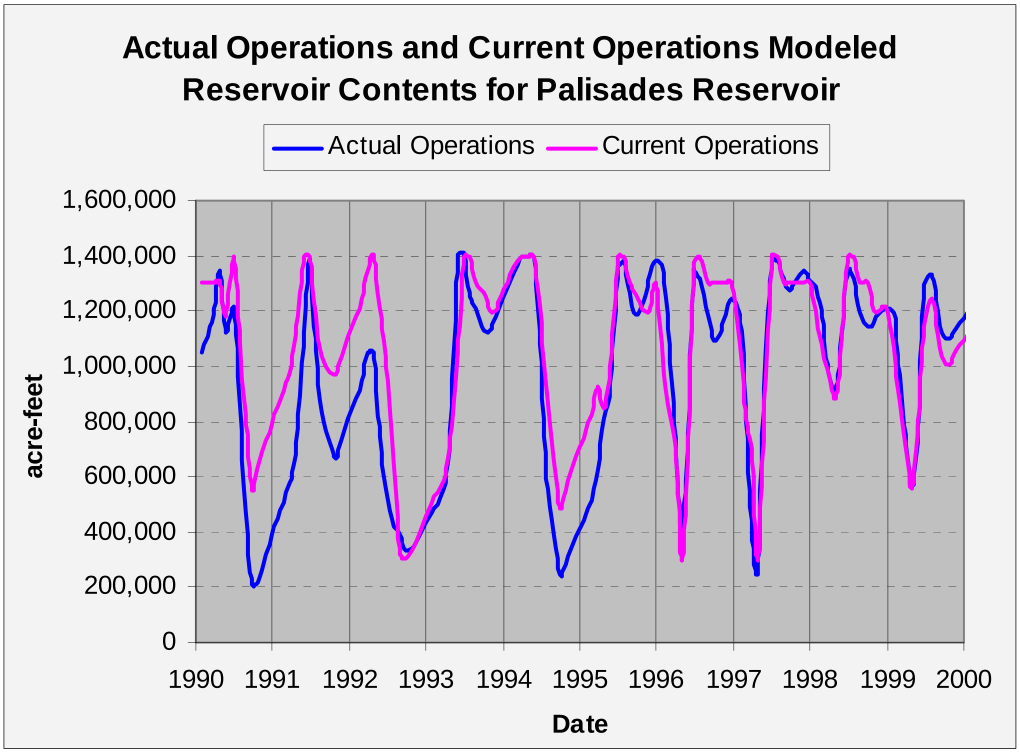
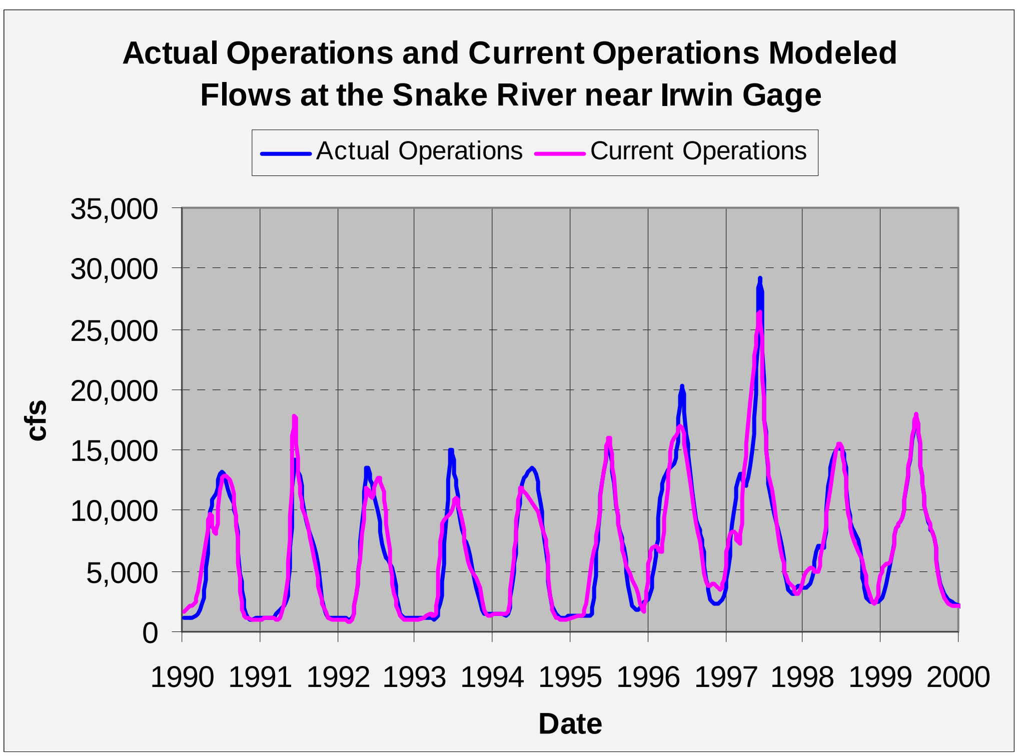
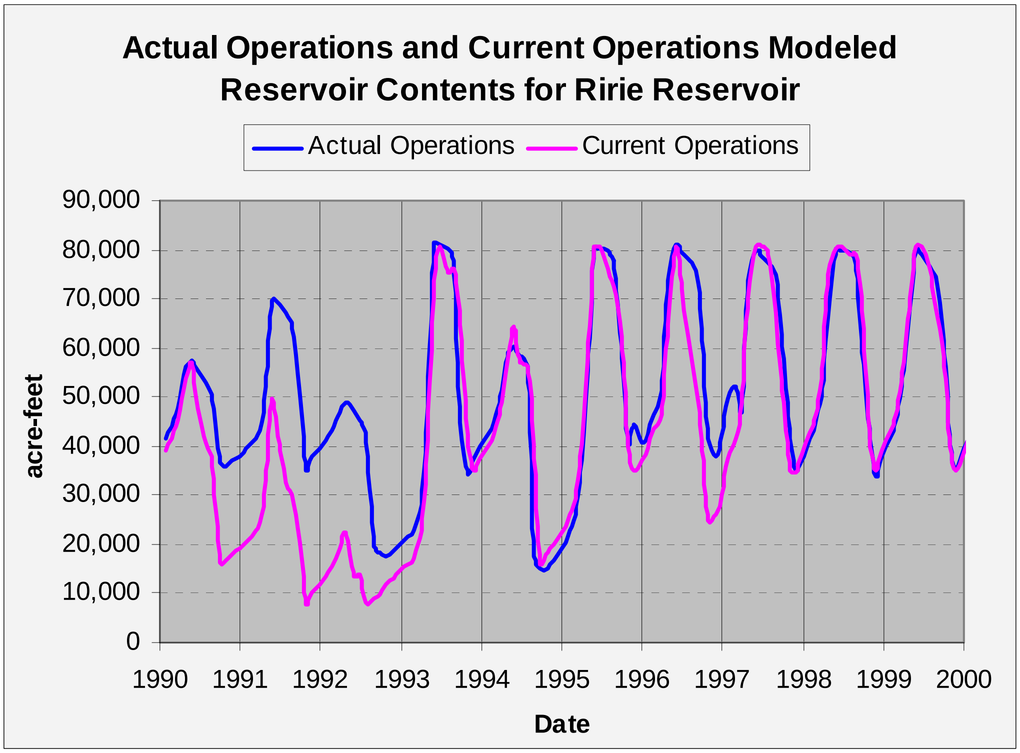
1995
1996
1997
1998
1999
2000
Date

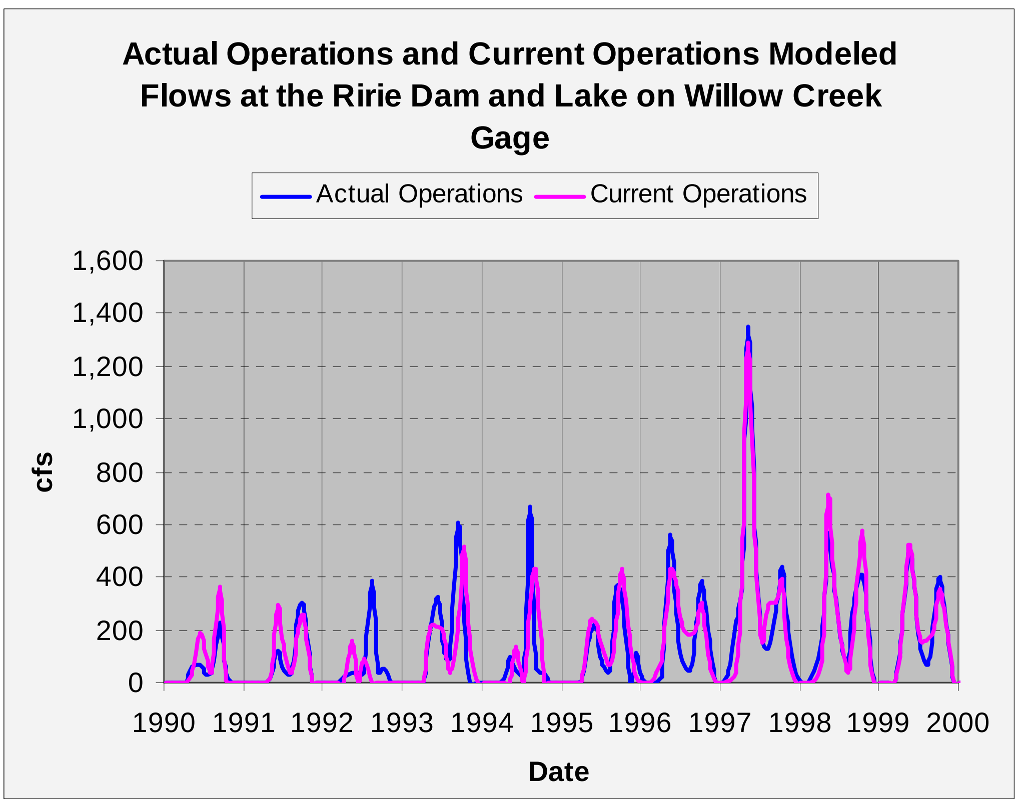

Actual Operations and Current Operations Modeled
Flows at the Snake River at Milner Gage
Actual Operations
Current Operations
cfs
25,000
20,000
15,000
10,000
5,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Snake River at Weiser Gage
Actual Operations
Current Operations
cfs
60,000
50,000
40,000
30,000
20,000
10,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Palisades Reservoir
Actual Operations
Current Operations
acre-feet
1,600,000
1,400,000
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Snake River near Irwin Gage
Actual Operations
Current Operations
cfs
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Reservoir Contents for Ririe Reservoir
Actual Operations
Current Operations
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
acre-feet
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date


Actual Operations and Current Operations Modeled
Flows at the Ririe Dam and Lake on Willow Creek
Gage
Actual Operations
Current Operations
1,600
1,400
1,200
1,000
800
600
400
200
0
cfs
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
Date

E.7 Literature Cited

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